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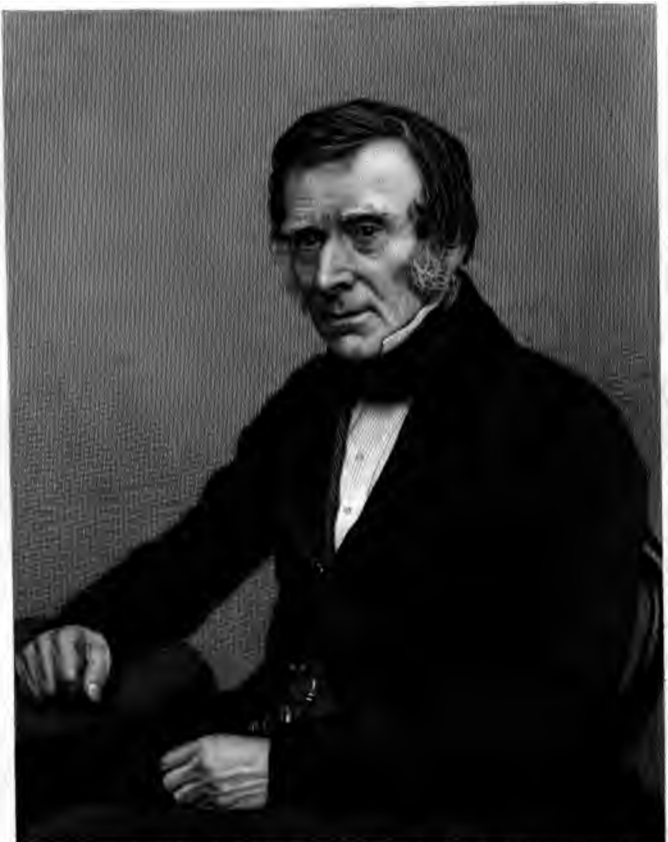

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THE

YEAR-BOOK OF FACTS

IN

Science and Art:

EXHIBITING

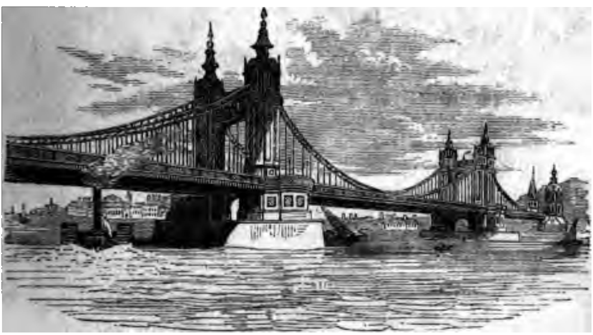
THE MOST IMPORTANT DISCOVERIES AND IMPROVEMENTS OF THE PAST YEAR,

IN MECHANICS AND THE USEFUL ARTS; NATURAL PHILOSOPHY; ELECTRICITY; CHEMISTRY; ZOOLOGY AND BOTANY; GEOLOGY AND MINERALOGY; METEOROLOGY AND ASTRONOMY.

BY JOHN TIMBS, F.S.A.

AUTHOR OF "CURIOSITIES OF SCIENCE," ETC.

"The steam-engine in its manifold applications, the crime-decreasing gas-lamp, the lightning conductor, the electric telegraph, the law of storms and rules for the mariner's guidance in them, the power of rendering surgical operations painless, the measures for preserving public health, and for preventing or mitigating epidemics,—such are among the more important practical results of pure scientific research, with which mankind have been blessed and States enriched."—*Address of Professor Owen, President of the British Association, at Leeds*, 1858.



New Suspension Bridge, Chelsea.—(See page 47.)

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SIR BENJAMIN COLLINS BRODIE, BART., D.C.L.

PRESIDENT OF THE ROYAL SOCIETY.

(*With a Portrait.**)

THIS distinguished Surgeon has lately been elected to the Presidential Chair of the Royal Society, the highest honour which in this country can be bestowed upon a *savant* by his compeers. That such distinction has been nobly earned by Sir Benjamin Brodie, will be acknowledged by every one who glances at the published results of his long professional life, in his valuable contributions to Surgery and the collateral sciences.

Sir Benjamin Collins Brodie is the grandson of a younger branch of the ancient Scottish family of Brodie, and is the third son of the late Rev. Peter Bellinger Brodie, M.A., Rector of Winterslow, near Salisbury, Wilts, by Sarah, daughter of Benjamin Collins, Esq., of Milford, also near Salisbury. "His father's sister was married to Dr. Denman, father of the late Chief Justice Lord Denman, and an elder sister of his mother was married to the late Sir George Staunton, Bart., author of the Narrative of 'Lord Macartney's Embassy to China.' The elder brother of Sir Benjamin was the late Mr. Brodie, well known as holding the highest rank in his profession as a Conveyancer;" and his second brother sat in Parliament for Salisbury.

Sir Benjamin was born at Winterslow, in 1783; was educated at home by his father; and upon his removal to the metropolis, commenced his studies for his future profession by attending the Lectures on Anatomy at Mr. Wilson's Hunterian School in Great Windmill-street. He next became a pupil of Mr. (afterwards Sir Everard) Home, at St. George's Hospital; and he was subsequently associated with Sir Everard in his dissections in Comparative Anatomy. For seven years (1805 to 1812), Mr. Brodie taught Anatomy at the Hunterian School, first as Demonstrator in the dissecting-room, and subsequently as Lecturer in the theatre; on retiring from which duties he was succeeded by Sir Charles Bell.

In 1808, Mr. Brodie was appointed Assistant-Surgeon to St. George's Hospital. He was afterwards elected Surgeon, which office he filled until the year 1840. His Lectures on Surgery were well attended; and subsequent to 1830 he delivered Clinical Lectures to the Students gratuitously.

In 1819, he was appointed Professor of Anatomy to the Royal College of Surgeons, which office he resigned in 1823. In 1837, he delivered the Annual Oration at the College, upon the birthday of

* *Engraved by permission*, from the *Photographic* Portraits of Living Celebrities, *by Messrs. Maull* and Polyblank; and a few of the data in the following *pages are from Mr.* Walford's neatly-written Memoir in the same work.

John Hunter, whose character and genius Mr. Brodie illustrated with great felicity.

Nearly half a century since (in 1810), he was elected a Fellow of the Royal Society; and in the following year he received the Copley Medal, for various papers printed in the *Philosophical Transactions.* Thus, in 1809 he contributed an "Account of the Dissection of a Human Fœtus, in which the Circulation of the Blood was carried on without a Heart;" "On some Physiological Researches respecting the Influence of the Brain on the Action of the Heart, and on the Generation of Animal Heat," 1811; "Experiments and Observations on the different modes in which Death is produced by certain Vegetable Poisons," 1811, on which he made further communications in the two following years. These papers were republished in a separate form, with notes, in 1851. In 1814 appeared his "Experiments and Observations on the Influence of the Nerves of the Eighth pair on the Secretions of the Stomach."

Sir Benjamin Brodie appears to have taken considerable interest in the internal affairs of the Royal Society, for in the second volume of Mr. Weld's *History*, we find the following letter concerning Sir Joseph Banks's ideas as to the admission into the Society:

"14, Savile-row, April 7, 1848.

"MY DEAR SIR,

"The view which Sir Joseph Banks took of the construction of the Royal Society was, that it shall consist of two classes:—the working men of science, and those who, from their position in society, or fortune, it might be desirable to retain as patrons of science. Sir Everard Home wished to propose Dr. Vaughan (who was then in *very large* practice as a metropolitan physician,) as a Fellow of the Society, but Sir Joseph would not agree to it. He said he would not allow a gentleman to be qualified for admission into the Society merely because he was a fashionable physician. After some years, Dr. Vaughan inherited a fortune, and became Sir Henry Halford. Sir Joseph then said that he might now be admitted as belonging to the other class. Sir Henry was accordingly elected.

"Sir Everard Home at another time asked Sir Joseph's consent to his proposing Dr. Warren as a Fellow; but Sir Joseph gave the same answer. Dr. Warren was afterwards elected a Fellow with Sir Joseph's concurrence, as being a member of the Animal Chemistry Society. "I am, &c.,

"B. C. BRODIE."

Sir Benjamin has for several years possessed the first surgical practice in the metropolis; and this success, more than a quarter of a century since, brought him the highest patronage. In 1828, he was appointed Surgeon in Ordinary to King George the Fourth; and he took part in the *post-mortem* examination and embalming of the Royal remains. In 1832, on the death of Sir Everard Home, Serjeant-Surgeon to King William the Fourth, the office was conferred upon Mr. Brodie, who, in 1834, received the honour of a Baronetcy. Sir Benjamin is now Surgeon to the Queen, and Surgeon to the Prince Consort.

In 1856, Sir Benjamin Brodie received from the University of Oxford the honorary degree of D.C.L. He is a corresponding member of the Institute of France, and a foreign member of other learned Societies and Academies in Europe and America.

Among Sir Benjamin Brodie's published works are his papers in the *Transactions of the Royal Medical and Chirurgical Society*. His

Pathological and Surgical Observations on the Diseases of the Joints has reached a fifth edition, and his *Lectures on Diseases of the Urinary Organs*, a fourth edition: these originally appeared in the *Medical Gazette*, to which Sir Benjamin Brodie largely contributed. His *Psychological Inquiries*, illustrating the mutual relations of the physical organization and the mental faculties, has reached the third edition.

In November last, Sir Benjamin Brodie was honoured with an additional testimonial to his skill and high character, by his election as President of the New Medical Council, under the Act to regulate the Qualifications of Practitioners in Medicine and Surgery, passed in the last Session of Parliament. Immediately following the above election, the following merited tribute to the professional and personal merits of Sir Benjamin Brodie appeared in the *Lancet* for November 27:—

"If any man may legitimately look with pride and satisfaction upon a career of brilliant and undimmed success, unspotted by a moral blot, and darkened by no shadow, but daily more rich in honour, and pre-eminent in usefulness, that man, amongst us, is Sir Benjamin Brodie. Gifted with singular acuteness, with an invincible love of labour, with clear-sighted vision of the truth, and with peculiar firmness and morality of mind, he has long filled the public eye with the image of a man who shows how high are the qualities which a great surgeon can possess. In him we have been respected, and by him we would be represented. The honour of election to the office of President of the Medical Council, which on Tuesday night befel Sir Benjamin Brodie, is the highest which the profession possesses in its gift. On Monday next, Sir Benjamin, Brodie will be elected President of the Royal Society. It is a rare fortune which crowds distinctions so singular within the space of a few days. It is, perhaps, as unusual that they should be bestowed with common consent, and amidst general plaudits. The verdict of the world of science confirms the voice of the profession, and it is a matter of sincere congratulation—one which is of vast importance to the profession—that our representative is a man whom the wisest and the most powerful intellects in the country have elsewhere elected to a place of authority and weight."

On November 30, Lord Wrottesley having formally resigned the Presidential Chair of the Royal Society, Sir Benjamin Brodie was elected President as his Lordship's successor.* In the list of Presidents are the names of three distinguished Physicians—Sir Hans Sloane, Sir John Pringle, and Dr. Wollaston; but the present is the first instance of the Chair being filled by a Member of the College of Surgeons; and the distinction could not have been conferred upon a *savant* with higher qualifications than Sir Benjamin Brodie possesses,—to promote the main object of the Society—"investigation into the laws of Nature."

Sir Benjamin married, in 1815, Anne, daughter of Mr. Serjeant Sellon, by whom he has a family. The eldest son, Mr. Benjamin Collins Brodie, B.A., is Aldrich Chemistry Professor in the University of Oxford. Abstracts of several of his contributions to chemical science will be found in the *Year-Book of Facts*.

* See pp. 100—103 of the present volume.

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THE

YEAR-BOOK OF FACTS.

Mechanical and Useful Arts.

STEAM NAVIGATION.—THE GREAT EASTERN.

AT the late Meeting of the British Association,* Mr. W. Fairbairn, President of the Section of Mechanical Science, thus characterized the recent progress of Steam Navigation:

"In this department of practical science, although much has been done, yet much remains to be accomplished in giving to the iron ship uniformity of strength and security of construction. In vessels of such complex form, bounded by such a variety of curved surfaces, we are yet much at sea as to the precise points of application of the material in order to attain the maximum of strength combined with lightness and economy in the distribution of the material. These are data yet to be ascertained, and it will require long and laborious experimental researches before the facts are clearly known and established. Much has, however, been accomplished in the absence of these data, and I may safely refer to that noble structure the *Leviathan*, which, with all her misfortunes, is, nevertheless, a most magnificent specimen of naval architecture. The cellular system, so judiciously introduced by Mr. Brunel, is her great source of strength, and I am persuaded that she will stand the test (which I have recommended in other cases) of being suspended upon the two extreme points of stem and stern with all her machinery on board; or, these conditions being reversed, I believe she may be poised upon a point in the middle, like a scale-beam, without fracture or injury to the material of which she is composed. Her cellular construction and double sheathing round the hull, and the same formation on the upper deck, give to the vessel enormous power of resistance, and her division and subdivision by bulkheads ensure a large margin of security in whatever circumstances she may be placed. In fact, she may be considered as a large hollow girder requiring a load of nearly 10,000 tons suspended from the centre to break her. I mention this to show that her want of success is not due to any fault in the ship herself, but to the magnitude of the speculation as a commercial transaction, and her unmanageable character in regard to the shipment of cargo, and similar difficulties which she may be

* Held at Leeds, in September last, under the very able Presidency of Professor Owen. This is generally considered to have been the most brilliant Meeting of the *Association since its establishment.* Of the proceedings, more especially the *opening Addresses of the President* of the General Meeting, and of the Presidents *of the Sections, several* quotations are given in the following pages.

called upon to encounter. I hope, however, that the necessary funds will be forthcoming to complete her equipment, and that we shall yet see her dashing aside the surge of the Atlantic at a speed of 18 to 20 knots an hour."

We have only to add, that the Launch of the great ship was completed on January 31, (the day of the publication of the *Year-Book of Facts*, 1858, with the Portrait of her Builder, Mr. Scott Russell,) this being about three months from the date of the first attempt at launching. The operation is calculated to have cost about 60,000*l.* or 70,000*l.* The name has been reversed to the *Great Eastern.*

The Company originally formed for building the vessel has been dissolved; and a new Company has been organized to complete her equipment, which has been already the subject of many artistic anticipations.

CHERBOURG.

THE Napoleon Docks were opened with great pomp and circumstance, on August 5, by the Emperor of the French,—Queen Victoria and the Prince Consort being present on the occasion, which was much commented on by the public journals. By a singular coincidence, upon the same day, Telegraphic communication by the Atlantic Cable was completed—in the ideal contrast, the peaceful triumph dimming the vain glory of war.

The works at Cherbourg are of a gigantic description, and have been carried on during seventy years. The principal works, so far as the marine engineers are concerned, were completed by 1854, at a cost of nearly three millions sterling. Mr. G. R. Burnell says, in general terms, the Cherbourg breakwater may be described as presenting a mass of rubble stone, having a slope, from the bed of the sea to the level, of nearly 22 feet below high-water line of spring tides, towards the roads in the ratio of one base to one in height (1 to 1). The top of the mass then has a much more gentle inclination; for in the width of 19¼ feet its inner summit attains the level of 15¾ feet below high-water line, and there it stops against a wall, almost vertical, rising 7 feet above the same high-water line or datum. There is a level platform at this height of 20¼ feet wide on the eastern arm, and 21 feet wide on the western arm; and beyond it there is a solid masonry parapet (about 5 feet high, and rather more than 8 feet wide) towards the sea. The outer line of this parapet is, in fact, in the continuation of the sea face of the wall, and the latter has been built of coarse and dressed masonry, laid with the greatest care, and composed of the very best materials, upon a general bed of hydraulic concrete 5 feet thick, laid over the loose rubble hearting. The bottom of the concrete is about 29 feet below datum. Beyond the edge of the masonry which protects the foot of the vertical wall, the top of the rubble hearting of the breakwater has assumed a slope of 1 in 10 towards the open sea under the influence of storms. This slope continues until the top line has descended to 47 feet below datum, and thence it continues to the bottom at the rate of 1½ to 1.

The small materials used in the hearting of the breakwater are naturally exposed to be displaced by storms. Of late, however, a very effectual mode of protecting the sea slope has been adopted, consisting of huge artificial blocks, cubing not less than 26 yards, placed upon those portions of the breakwater which are most exposed to the effects of the sea. These blocks are composed of rubble masonry and of Portland cement mortar, the cement being English, of the manufactory of White and Sons, Westminster.

Returning, however, to the consideration of the general plan of these offensive and defensive works, we find that there is at the apex of the angle formed by the meeting of the two branches of the breakwater, a large central fort, having a total development of about 509 feet, measured on the inner line of the parapet, which forms a very flat semi-ellipse. Behind this battery there is to be raised an elliptical

central tower, measuring 225 feet on the major, and 123 feet on the minor axis. A casemated fort, of about 190 feet front, is to be formed on the western or longer branch, and two large circular forts are placed at the extremities of the breakwater; that of the eastern end being 100 feet in diameter, and that of the western end about 133 feet in diameter.

The military port of Cherbourg consists of an outer harbour, 776½ feet long by 662¾ feet wide, with a *minimum* depth of water of 58½ feet. The channel at the entrance is 206 feet wide at the narrowest point, and is usually 530 feet wide. The cost of this outer harbour was estimated at nearly 680,000*l*. Beyond it, and communicating with it by means of a lock of about 130 feet long and 58 feet 7 inches wide, is a floating basin 957 feet long by 712 feet 9 inches wide. There are on the opposite side of the outer harbour to this floating basin, four fine covered building slips for 120-gun ships, and a graving dock close by a caisson, besides some uncovered slips for building smaller classes of ships. The building slips for vessels of the line are 383 feet long by 78 feet 8 inches wide. The graving dock is 245 feet long by about 78 feet wide, with a depth of water over the sill of about 27 feet 6 inches.

The inner floating harbour has been inaugurated. It is parallel to the first floating basin, and will communicate both with the outer harbour and the basin. It is about 2788 feet long by about 1312 feet wide, and is entirely excavated out of the solid rock—a member of the transition series, extremely hard and tough. All round this marvellous sheet of water is a series of graving docks and building slips of remarkable beauty, so far as we may judge of them by their present state, at least; and immediately beyond the quays are the various magazines, storehouses, sail-lofts, shops, &c., which, when complete, will render Cherbourg one of the most complete arsenals in Europe. When the works still unfinished shall have been executed, Cherbourg will constitute one of the most formidable military and naval posts in the world.

THE ORDNANCE SURVEY.

THE National Survey of the United Kingdom is based upon a system of triangulation, extending over the whole country. The distances between the trigonometrical sections are derived from the measured base line on Salisbury Plain, and on the north shore of Lough Foyle, in the north of Ireland. This most important branch of the work has been executed with the greatest accuracy, the difference between the measured lengths of the bases of verification and their computed lengths not exceeding 2½ inches in 7 miles. The average length of the sides of the triangles in the principal triangulation is about 60 miles, but many of the sides exceed 100 miles in length. The primary triangulation is next broken up into smaller triangles, the sides of which are from 5 to 10 miles in length, and this secondary triangulation is again broken up into triangles the sides of which are about one mile long, to form the tertiary or minor triangulation. The men employed to make the detailed survey then actually measure the length of each side of the minor triangles on the ground, noting in their "field-books" every fence, stream, or other object they may cross; they then measure cross lines from one side of the triangle to the other, and, by taking offsets from the measured lines to every object on the face of the country, they obtain in their field-books the data for plotting accurate plans upon any scale which may be required. The length of every measured side of a triangle is therefore checked by the computed trigonometrical distance, and the accuracy of the lines within each triangle is checked by the plotting, and *thus no errors can escape* detection. By this method perfect *accuracy is obtained, not only* in every part of the detail of the survey, *but every object is exactly* in its correct relative position to every

other object, however distant. The levels engraved on the plans are all given in relation to one datum level, that for Great Britain being the level of mean tide at Liverpool.

The scales which have been adopted for the plans are as follows:— Town maps, 60 inches to a mile, or 1-500th of the actual linear measure; parishes, 25·334 inches to a mile, or 1-2500th of the actual measurement; counties, 6 inches to a mile; and the general map of the kingdom, 1 inch to a mile. The parish plans are engraved upon zinc; and the plans of towns, counties, and the general map of the kingdom, are engraved upon copper. Zincography is now generally adopted, instead of lithography, on account of the facility of handling zinc plates rather than lithographic stones, which are necessarily heavy, and are constantly liable to be broken. Copies of the plans are sometimes also produced by a new patent process, called the "Anastatic process," by which any drawing or print, however old, but which has originally been made with a greasy ink, may be transferred to a zinc plate, and copies of it obtained by printing from the zinc. The reduction of the scale of the 1-inch plans from those of a larger size is done by means of photography. The collodion process is employed for the purpose of taking the negative copy. The lens of the camera used is a single achromatic meniscus, 3½ inches in diameter, with a principal focal length of 24 inches. The plan to be reduced is attached to a board, which can be adjusted by a screw to any height that may be required, and turns upon a centre pivot. The camera is placed opposite to it on a table which runs upon wheels upon a small tramway laid down on the floor of the photographic room, and the required scale of the reduction is obtained by tracing on the ground glass of the camera a rectangle corresponding on the reduced scale to the rectangle of the plan to be reduced. The curvature of the image and the indistinctness of outline from spherical aberration are both remedied by reducing the diaphragm in front of the lens to a small aperture. From the negative thus obtained on glass, as many positive copies on paper as are required are then taken in the usual way. The introduction of this method has greatly lessened the cost of reducing the plans, and also saves an immense quantity of time and labour. The 6-inch map is engraved in sheets 3 feet by 2 feet, the sheets of each county being made to fit together by the marginal lines, so as to form, if required, a single plan. A considerable saving in the cost of engraving the Ordnance Maps is effected by using steel punches to cut the woods, figures, rocks, &c., on the copper plates; the work is thus done much more quickly than by hand, and boys are employed at it in the place of skilled engravers. A portion of the writing also on the copper plates is engraved by machine (Becker's patent), and the parks and sands are ruled by machine with a steel dotting wheel, the pressure of the wheel and the interval between the dots being regulated according to the tint required to be produced. The ink used in the copper-plate printing consists of Frankfort black with a mixture of Prussian blue, ground with burnt oil in a mill constructed at the Ordnance Map office, at Southampton, for the purpose. After printing, the impressions are first dried between millboards, and are

then placed between glaze boards and pressed in an hydraulic press, after which they are ready for issue.—*Times*, Aug. 21, 1858.

SOCIETY OF ARTS.

Mr. C. Wentworth Dilke, chairman of the Council, delivered on November 17th the opening Address. We give the more important paragraphs:—"In the Address read last year, three subjects were prominently noticed as requiring the attention of the Council—Artistic Copyright, Parcels Post, and Resources of India. Considerable progress has been made with reference to the amendment of the law of Artistic Copyright. The Committee, composed as it was of men eminent as painters, sculptors, engravers, and patrons of art, lawyers, and others well acquainted with the subject, having for their chairman Sir Charles Eastlake, the President of the Royal Academy, at the end of the last session made their Report to the Council, embodying the principles on which any amendment of the law should be based, and they accompanied that Report with a draft of a Bill for carrying their views into effect. This Report, however, was not made until it was too late to bring the matter fully before the Legislature. Nevertheless, Lord Lyndhurst, who kindly undertook the charge of the Society's petition to the House of Lords, on presenting it as well as petitions from other bodies and individuals, moved for and obtained a Committee of Inquiry on the subject. Owing, however, to the session of Parliament then drawing near its close, this Committee did not enter on the inquiry; but it is hoped that, on the opening of Parliament next year, the Committee will be re-appointed, and that the session will not close without some well-considered amendment of the law. The Council have already appointed a small Committee, on which Sir Charles Eastlake has consented to serve, for the purpose of taking such measures as may be thought right for best promoting in the Legislature those views which the large and influential Committee of the Society, last year, set forth in their Report." * * * * * Another subject, however, of great importance, occupied much of the attention of the Council—viz., the propriety of holding a second Great Exhibition in 1861.

The adjudicators appointed by the Society to report on the merits of the twenty-two Essays sent in in competition for the prize of two hundred guineas offered by Mr. Henry Johnson, have made their award, and the prize has been paid, with Mr. Johnson's consent, to Mr. Edward Capps, of Cheshunt-terrace, Bermondsey.

The medals were then presented as follows:—

To Mr. J. A. Clarke, for his essay "On the Application of Steam-power to the Cultivation of the Soil."

To Mr. A. G. Findlay, for his paper "On the Progress of the English Lighthouse System."

To Mr. W. L. Scott, for "A Self-registering Maximum Thermometer for great depths at Sea."

To Mr. W. Stones, for his paper "On New Zealand and its Resources."

To Mr. F. R. De la Tréhonnais, for his paper "On the Past and Present of French Agriculture."

To Mr. J. Underwood, for his paper "On the History and Chemistry of Writing

Printing, and Copying Inks, and a new plan of taking Manifold Copies of Written and Printed Documents," &c.

To Dr. J. F. Watson, for his paper "On the Composition and Relative Value of the Food Grains of India."

To Mr. W. Williams, for his "Machine for Cutting and Dressing Stones for Building Purposes."

To Mr. J. W. Wilson, for his "Combination of the Tubular Gouge and Disc-paring Tool for Wood-shaping Machinery."

To Professor J. Wilson, for his paper "On Canada: its Productions and Resources."

INSTITUTION OF CIVIL ENGINEERS.

THE Annual General Meeting was held on the 14th of December. Mr. Joseph Locke, M.P., President, in the chair.

The Report of the Council for the past session, which was read, commenced by regretting that there had not been a general resumption of works of public utility and of private enterprise in the United Kingdom; a large proportion of the professional engagements being still in foreign countries, or in the British colonies. In India the suspended works upon the different railways had been resumed, and it was fair to conclude would now be pushed forward with vigour. On the continent but little progress had been made, except in the construction of branch lines.

The various Spanish railways in operation, or in progress of construction, were then noticed; and it was stated that in Austria, the Lombardo-Venetian Company, under the able direction of M. Paulin Talabot, had united the majority of the principal lines, with a view to the ultimate formation of one comprehensive system, which would be one of the most considerable in Europe, as it would consist of nearly 1900 miles of railway, connecting Austria, Hungary, and Southern Germany with Trieste and Italy, and extending in an unbroken line from Vienna to Milan, and from the Bavarian frontier to Florence.

At home, an important feature in the railway extensions in the vicinity of the metropolis was the Victoria station, Grosvenor-basin, Pimlico, under Mr. Fowler. This site was said to be peculiarly fitted for a railway, as, from the previous formation of the roads and bridges, the levels of the rails could be so arranged as to avoid interference, by inclined approaches, with the adjoining streets or properties, whilst affording extensive frontage upon wide streets, at present not encumbered with traffic. The works, including a bridge across the Thames, consisting of four arched spans of wrought iron of 175 feet each were then in progress.

Special attention was directed to a very interesting series of photographs of some important structures in the city of Washington, U.S. America, now in progress, or recently completed, under the direction of Captain Montgomery Meigs, U.S. Engineers, by whom the views were presented to the Institution.

The Council awarded, in July last, the following premiums for papers read at the Meetings during the past Session:—

1. *A Telford Medal to* J. Atkinson Longridge, and a Council Premium of Books *to C. H. Brooks, for their paper* "On Submerging Telegraphic Cables."

2. A Telford Medal to G. Robertson, for "An Investigation into the Theory and Practice of Hydraulic Mortar."

3. A Telford Medal to J. Henderson, for his paper "On the Methods generally employed in Cornwall, in Dressing Tin and Copper Ores."

4. A Telford Medal to R. Jacomb Hood, for his paper "On the Arrangement and Construction of Railway Stations.

5. A Telford Medal to Major-General G. B. Tremenheere, for his paper "On Public Works in the Bengal Presidency."

6. A Telford Medal to Alfred Giles, for his paper "On the Construction of the Southampton Docks."

7. A Watt Medal, and the Manby Premium in Books, to Lindsay Molesworth, for his paper "On the Conversion of Wood by Machinery."

8. A Watt Medal to T. Spencer Sawyer, for his paper "On the Principal Self-acting and other Tools employed in the Manufacture of Engines, Steam-boilers," &c.

9. A Council Premium of Books to F. C. Webb, for his paper "On the Practical Operations connected with Paying-out and Repairing Submarine Telegraph Cables."

10. Ditto to H. Conybeare, for his paper, "Description of Works recently executed for the Water Supply of Bombay, in the East Indies."

11. Ditto to S. Alfred Varley, for his paper "On the Qualifications requisite in a Submarine Cable, for most efficiently transmitting Messages between distant Stations."

12. Ditto to R. Carden Despard, for his paper, "Description of Improvements on the Second Division of the River Lee."

13. Ditto to Alexander Wright, for his paper "On Lighting Mines by Gas."

14. Ditto to J. Brunlees, for his "Description of the Iron Viaducts erected across the Estuaries of the Leven and Kent, in Morecambe Bay."

It may be mentioned that two of these awards, the Watt Medal and the Manby Premium, were then presented for the first time. The former originated with the Council, who were desirous of possessing some distinctive means of rewarding excellence in communications upon mechanical subjects. The medal has been executed by Mr. J. S. Wyon. On the obverse is a beautifully-executed medallion likeness of James Watt, and on the reverse a representation of the steam-engine as constructed by him. The Manby Premium is due to the liberality of Mr. C. Manby, who has filled the office of secretary for the last nineteen years, and with so much satisfaction to the members that a few months back they presented him with a clock and candelabra, and a cheque for 200*l.* In acknowledging this handsome testimony of his services, Mr. Manby requested that the Council would receive debenture stock of the value of 200*l.* bearing 5*l.* per cent. interest, to be expended in an annual premium. In accepting this offer it was resolved that the premium in question should bear the title of the "Manby Premium."

THE DEPARTMENT OF SCIENCE AND ART.

The Fifth Report of the "Science and Art" Department has been published in a blue-book of 160 pages. The duties of the Department consist of a general superintendence over several distinct institutions for the promotion of science, the aiding of schools, and the direction of a training school for art masters, and a museum and library at South Kensington. The usual notice is taken of each of the metropolitan institutions. The Museum of Practical Geology was visited last year by 17,197 persons. That useful institution, "the Government School of Mines," in Jermyn-street, appears to

be in a flourishing and progressive state. Last year there were 11 matriculated and "perpetual" students, and 66 occasional. The course of study includes physics, metallurgy, chemistry, natural history, geology, and applied mechanics. The lectures to operatives in natural history (Professor Huxley), geology (Professor Ramsay), and applied mechanics (Professor Willis), have been the same as in 1854; they are eagerly sought after. The students attending the chemical laboratory under Dr. Hoffman have increased to 116. Two young gentlemen who passed through the *curriculum* at Jermyn-street with credit have been appointed "exploring geologists" in surveys undertaken by the Government. One of them, Mr. Bauermann, proceeds to the Rocky Mountains of America; the other, a Mr. Thornton, accompanies Dr. Livingstone to South Africa.

The South Kensington Museum now comprises nine separate collections (organized by Mr. Cole), including a circulating art library, and the famous Sheepshanks gallery of pictures.

THE ROYAL OBSERVATORY.

THE Annual Visitation of the Royal Observatory was held on June 5, on which occasion the Astronomer Royal submitted a Report of the Proceedings of the Observatory during the past year to the Board of Visitors. In the Observatory buildings, the new south-east dome has been constructed.

The object-glass for the new equatorial has been furnished by Messrs. Merz and Son, of Munich. The Astronomer Royal has made various trials of it in a temporary tube carried by a temporary mounting, and is well satisfied with it. He cannot yet say that he has certainly divided the small star of γ *Andromedæ*, but for such a test a combination of favourable circumstances is required. From what he has seen, he has no doubt of its proving a first-rate object-glass. The north support of the polar axis, and the adjustable parts of the south support, are mounted in their places. The other parts of the instrument, by Messrs. Ransomes and Simms, were very nearly ready. The hour-circle clamps and slow motions, the declination axis, the declination circle, the declination-circle clamps and slow motions, and the clockwork, were in different stages of advance. The engineers expressed themselves satisfied and almost surprised at the stiffness given by the bracing in the temporary erections of the polar frame. Thus it is evident that the new equatorial will be one of our finest national astronomical instruments. The magnificent transit circle was stated to be in good working order.

A new chronometer oven has been prepared, which is expected to prove of considerable benefit to the service of the Royal Navy. Every chronometer which is sent to the Observatory is now rated for some weeks in a temperature of about 80°, and sometimes higher.*

The galvanic apparatus, (says the Report,) so far as it is included within the Observatory, is in good order. By some parts of the apparatus the system of

* *In connexion with this improvement, we may be allowed to mention that a detailed account of the mode by which Chronometers are rated at the Royal Observatory will be found in the Curiosities of Science*, (lately published,) by the Editor *of the present volume.*

sympathetic clocks is kept in motion; by other parts the time-ball is dropped, and hourly currents are transmitted to the South-Eastern Railway and to the Lothbury Station of the Electric Telegraph Company, from which communications are made at one hour to the time-ball at Deal, and to other time-balls in the Strand, Cornhill, and Liverpool. By other parts currents are sent for maintaining the action of a clock at the South-Eastern Railway Station, by which communications are automatically altered; by other parts, the Observatory possesses the power of giving touch signals from the eye end of the transit circle to any of the wires of the Electric Telegraph Company, or of the British and Submarine Company. The communications, however, external to the Observatory, have been in a bad state. The four wires to London Bridge were injured, as is believed, by a thunderstorm during the autumn of 1857.

In spite of the injury to the London galvanic wires, the currents transmitted at mean noon every day have had sufficient power to effect the regulation of four clocks in the General Post Office, and also to exhibit the signals given by these clocks. The appearance at Greenwich is very curious. Near to 23h. 26m., 23h. 28m., 23h. 32m., and 23h. 36m., four signals are exhibited which are known to come from four certain clocks, and which, by comparison with the Greenwich clock, show the errors of those four clocks. These observations are recorded. Each of the four clocks is corrected, and they regulate a group of dependent clocks,—so that more than thirty clocks are kept very nearly to accurate time. This is believed to be the best instance of mechanical regulation that exists.

IRON BRIDGES FOR RAILWAYS IN INDIA.

It is gratifying to be able to state that notwithstanding the check which the formation of railways in India received in the late distracted state of that country,—the construction for the lines has in England almost uninterruptedly progressed during the past year. As an example, we may refer to the Keeal and Hottohur Bridges, which have been constructed for the East Indian Railway, by Messrs. Cochrane and Co., of the Woodside Iron-works, near Dudley, from the designs and under the directions of Messrs. Rendel, Engineers to the East Indian Railway Company. These bridges are composed of 1170 tons of wrought iron, and 150 tons of cast iron; and consist of nine spans, or openings, each span of 150 feet. They are formed of lattice-girders, the upper portion or top table being constructed in the form of a box having all the joints planed; while the lower portion is formed of flat bars, connected by turned pins; and the intermediate space is filled by flat bars, and channel iron placed diagonally, the former being used where they will be in tension, and the latter where they are subject to compression. Each span consists of two such girders, connected at the top by cross girders, and diagonal bracing bars, so as to give lateral stiffness to the structure. The roadway is carried by cross girders, secured to the lower portion, or tie; and upon these girders, the rails are placed. These are "Barlow's rails," 98 to the yard: they are connected by saddle-pieces, and secured to the cross girders by rivets or bolts. Each span rests on cast-iron bearing plates—the one end being fixed, and the other provided with friction rollers, to allow for contraction and expansion under various temperatures.

In the construction of these bridges, the chief merit appears to be that all the difficult pieces or parts are duplicates of one another; the object of the engineer in the arrangement being to secure the greatest simplicity, and thereby the greatest facility for erection in India, where skilled labour is not readily obtained; and to show how perfectly this has been accomplished by the contractors, we may

mention that a span was erected at their works in less than one week.

The bridges are constructed for a single line of rails; but the piers on which they rest are for a double line. On each side of the bridges, provision is made for foot passengers, which footpaths are so constructed, that one can be removed whenever it is determined to lay down another line of rails, and then fixed to the additional girders. At each end of the piers will be erected "pier-frames," of Eastern architectural design.

Not the least noteworthy fact connected with these bridges is that every piece in each of these vast structures had to be marked in such a manner as would enable their being put together without difficulty, and by the most ordinary workmen, on the site of their final resting-place. The entire work of these vast bridges has been completed in less than twelve months for shipment to India.

Another remarkable work of this class is the Wrought-iron Bridges, adopted by Lieut.-Colonel Kennedy, Engineer of the Bombay, Baroda, and Central India Railway. Here, rapidity of construction is of great importance, and the bridging of rivers a work of great difficulty. The crossing of the Jumna, for instance, which, it is understood, is to be bridged over on heavy piles of masonry, must be a labour of many years; whereas, the adoption of the wrought-iron principle (Warren's patent), would prevent this delay; and with cast-iron screw piles, the piers might be settled within the working months of the year.

Colonel Kennedy has adopted Warren's wrought-iron bridges and viaducts on the above line of railway; and among the great works is the long bridge for crossing the river Nerbudda, to be nearly three-quarters of a mile in length, which consists of 61 piers, and 60 spans each 60 feet clear. The bridge is on the equilateral triangle principle, each side being 7 feet 6 in. from centre to centre of pillar; eight of such lengths making the 60 feet span, the supporting piers being hollow cylinders. The great advantage of this girder bridge is that it requires very few hands to erect it abroad. The work has been executed by Messrs. Westwood and Co., at their works, London Yard, Isle of Dogs. The iron work was publicly tested with the following results:

> The first load weighed 15½ tons, and the deflection was 3-16 of an inch; the second making 31 tons produced a deflection of 5-16 of an inch; the third giving a total of 46 tons, 7-16 of an inch; the fourth, making 62, half an inch bore. The fifth waggon brought up the load to 77½ tons, and the deflection was half an inch; and the entire load of 124 tons produced a deflection of 5-8ths of an inch. On removing the load, the girders may be said to have resumed their original level, and no permanent set was observable. The load being run off, a bolt was removed, and showed no symptom of strain. The experiment was in every respect satisfactory, and highly creditable to the firm. The work appeared to be capitally turned out; and we understand the contract was accepted on terms very favourable to the Company.

The iron was then shipped at the Victoria Docks; and it was confidently expected that the Nerbudda Bridge, of which the above forms a part, would be completed within six months from such shipment.

STRENGTH OF BEAMS.

IMPORTANT progress has of late been made, in the adoption by practical men of correct principles as to the action of the particles of a Beam in resisting fracture; the knowledge of which principles had been formerly confined to a few mathematicians. They relate chiefly to the action of the *shearing force*, and its combination with that of the *bending force*, which latter was at one time the only circumstance considered. One of these results is, that the *neutral axis* of a beam, as it is called, is not, as it used to be described, a place of no strain whatsoever on the particles; but it is truly a place where, although the strain in a horizontal direction due to the bending force is nothing, the strain due to the shearing force is a maximum, and consists in a tension in one diagonal direction and a compression in another, each making an angle of 45 degrees with the horizon. Mr. Stephenson, lately, while referring to this fact, proposed a very ingenious method of verifying it experimentally. On the side of an unloaded beam, a series of small circles is to be drawn. When the beam is loaded, each of those circles will become an ellipse, whose dimensions are to be measured. It will be found that near the upper side of the beam each ellipse has its longer axis vertical, and its shorter axis horizontal; that near the lower side, each ellipse has its shorter axis vertical, and its longer axis horizontal; that at the neutral axis, each ellipse has its longer and shorter axes sloping at angles of 45 degrees, and that ellipses in intermediate positions have intermediate figures and obliquities.—*Prof. Rankine; Proc. Instit. Engineers of Scotland.*

BEAMS AND GIRDER BRIDGES.

A PAPER has been read to the Institution of Civil Engineers, on "Beams and Girder Bridges," by Mr. William Anderson, being in continuation of former communications on the same subject. Having shown the manner in which the strains in the several parts of uniformly-loaded beams were determined, Mr. Anderson concluded the theoretical part of his subject by considering the effect of passing loads. The analytical investigations were illustrated by numerous coloured diagrams, and many of the propositions were proved by means of an accurately-constructed model of a lattice beam, the property of Trinity College, Dublin, and lent for the occasion by the Engineering Professor. The several bars composing it being replaceable at will by spring balances, the theoretical deductions received the most direct proof of experiment.

THE UNIT OF HEAT.

PROFESSOR RANKINE, at the late meeting of the Institution of Engineers of Scotland, observed: "I am happy to recognise evidence that the true principles of the Mechanical Action of Heat, founded on the idea that heat is not a substance, but a form of energy, are making their way amongst practical men, and are being *usefully applied by them*. As a means of facilitating that progress,

by putting the expression of those principles into a shape more familiar to practical engineers than their present form, it was recently suggested by Mr. Stephenson, that, instead of the Unit of Heat commonly employed in scientific treatises—viz., so much heat as one pound of water requires in order to raise its temperature by one degree—quantities of heat should be expressed in terms of a unit which practical men oftener have occasion to think of—viz., so much heat as one pound of water at 212° of Fahrenheit requires, in order to convert it into steam at the same temperature; or what is commonly called 'the latent heat of one pound of steam at 212° of Fahrenheit;' being, in fact, the unit of heat now commonly employed in comparing the effects of different kinds of fuel and different forms of furnace. This suggestion of Mr. Stephenson appears to be well worthy of consideration and discussion. The following is a comparison of different units of quantity of heat, British and French, reduced to their equivalents in units of mechanical energy, as a common standard of comparison, based on the experiments of Joule:

BRITISH UNITS.

	Equivalent energy in foot-pounds.
One degree of Fahrenheit's scale in a pound of water .	772
One degree of the Centigrade scale in a pound of water	1390
Latent heat of one pound of atmospheric steam . .	745750

FRENCH UNITS.

	Equivalent energy in kilogrammètres.
One degree of the Centigrade scale in a kilogramme of water	4237
Latent heat of one kilogramme of atmospheric steam .	22730

One kilogrammètre = 7·23314 foot-pounds.
One foot-pound = 0·138253 kilogrammètres."

HAND HELIOSTAT.

By this simple instrument, the invention of Mr. J. Galton, which is comparatively inexpensive, as portable as a ship's compass, and which is moveable, a light can be flashed ten miles in such a manner as would attract the observation of the most careless person. It can be used from any spot where the sun's rays reached, as from between the trees of a forest, from a deer hill-side, or from the mast-head of a ship. It does not require a "sky-line." It has another peculiarity, in being enabled to flash its messages in perfect secrecy, except to those who happen to be stationed in the narrow path along which they were sent. Many occasions arise, especially in war time, where this invention would be of use. If the signaller is ignorant of the whereabout of his correspondent, he must sweep the horizon with his flash until it has been seen, and a response elicited. The instrument may be seen at the United Service Institution, Whitehall.

NEW LIFTING MACHINE.

The Scientific American states: David L. Miller has invented a machine embracing the three principles of the wedge, lever, and

screw, with which a workman at the Norris Locomotive Works, Philadelphia, weighing 156 pounds, lifts with facility the enormous weight of 37,332 pounds—more than eighteen tons—merely by the application of his strength through his hands to the lever.

COLLAPSE OF TUBES, GLOBES, AND CYLINDERS.

THE Report upon this inquiry has been presented to the British Association by Mr. Fairbairn. At the previous meeting, a Report was read upon the collapse of wrought-iron cylindrical tubes by uniform external force. Those experiments upon a ductile and fibrous material led to some novel and important results, and suggested the propriety of similarly testing the resisting powers of a perfectly homogeneous, crystalline, and rigid material, in order that our knowledge of the laws that govern the resistance of vessels to collapse might be confirmed and extended. Glass was selected, not only because of its fulfilling better almost than any other material the conditions sought for, and from the ease with which it could be manufactured into the forms required, but also because it was hoped that the results would be of practical value in those cases in the arts and in experimental science, in which it is so extensively employed. The experiments were conducted in a similar manner to those upon iron. Some cylinders and globes, blown out of good flint-glass, were procured direct from the maker. The open ends were hermetically sealed by means of the blow-pipe; and the globes, &c., were placed in a strong wrought-iron vessel capable of sustaining a pressure of 2000 lb. to the square inch. Water was pumped in by means of a force-pump; the pressure was recorded by a Schaffer's gauge; and the point of rupture was indicated by an explosion within the vessel, and by a sudden decrease of pressure.

The first experiments were upon glass globes, intended to be perfectly spherical, but in most instances somewhat flattened upon the side opposite to that from which they were blown. Notwithstanding this ellipticity, some of the globes bore enormously high pressures, especially when the extreme tenuity of the glass was considered, amounting, as it did, from only $\frac{1}{100}$ to $\frac{2}{100}$ of an inch in thickness. Mr. Fairbairn referred to and explained a table showing the diameter, thickness, and resisting powers of seven globes, three intended to be 5 in. diameter, one 5½ in., and three 8 in., but varying as before mentioned. The bursting pressure of the first four was 292 lb., 410 lb., 470 lb., and 475 lb. to the square inch—equivalent in the last case to 20 tons upon a 5½ in. globe, $\frac{1}{50}$ in. thick, before it was fractured. The 8 in. globes burst respectively at 35 lb., 42 lb., and 60 lb. to an inch; but they were unfortunately all elliptical to a serious extent, the diameters of that which burst at 42 lb. being respectively 8·20 in. and 7·30 in. The next experiments were upon glass cylinders blown with hemispherical ends. In the experiments upon iron, a remarkable law had been deduced—that the strength of cylindrical vessels exposed to a uniform external pressure, varied inversely as *the length. Thus,* with vessels precisely similar in every *respect, one twice the length* of another bore only half the pressure;

one three times the length bore only a third, and so on. It was now found that a similar law applied in the case of homogeneous glass cylinders. A cylinder 4·06 in. diameter, 13¾ in. long, and ·045 in. thick, collapsed under a pressure of 180 lb. to the square inch; while another, 4·05 in diameter, 7 in. long, and ·046 in. thick, yielded only under a pressure of 380 lb. to the inch. Various other examples were exhibited in a table.

"HUMAN" STEAM-ENGINE.

DR. ARNOTT has compared, with scientific minuteness, the structure of the human body to that of a steam-engine; but M. Lamy, of Paris, has carried the parallel still further, by constructing what he calls "the Organic Engine," from its being an imitation of the human organization. He describes it as consisting of a heart divided into two distinct parts, each comprising two compartments or cells, —one to contain the arterial or acting steam; the other the venous steam, or the steam which has already exerted its working power. The heart is represented by two cylinders, the motion of the piston exactly simulating the motions of sistole and diastole. There are two lungs, the conformation of which resembles as nearly as possible that of the lungs of animals, presenting under a given volume a very large surface. Here are to be seen veins, arteries, glands, and a stomach, the functions of which are of the same nature as those of the stomachs of animals. The steam represents the blood; and as the blood consists of a liquid which *drifts* various substances, so the steam acts, as it were, as a vehicle of the heart which constitutes the force, or the life (so to speak), of the engine. The leakage corresponds to the secretions, and the radiation of the engine may be compared to cutaneous perspiration. The inventor proposes to substitute his engine for the engines in common use on our railways, which he compares "to a man who has a vein constantly open, out of which the blood incessantly runs, and who requires a constant and large supply of food and drink in order to recover the blood lost."

STEAM HAMMERS.

MR. JOHN M'DOWALL, Walkinshaw Foundry, Johnstone, has invented an arrangement of the parts of Steam Hammers, and the system or mode of actuating the hammer. The stationary parts of the machine consist of a rectangular cast-iron base, which supports a column or pillar. To the upper part of this column is bolted a plummer-block, which carries a segmentally-ended lever, or a beam somewhat similar to the beam of the early pumping-engines, and in like manner vibrating upon a central axis. The beam projects over the front part of the base, and in a vertical line below it is a grooved plate, which forms the guide for the hammer-block to work in. The guide-plate is fixed to a frame, which projects from the front part of the fixed column or standard. The hammer-block is attached by a broad strap, or by a chain or suitable flexible connexion, to an eye at the outer end of the overhead lever; and is raised by admitting the steam to the cylinder upon the upper side of the piston, which is

thereby forced downwards, and carries with it the belt or chain, which is attached to the segmentally-ended lever connected to the hammer-block. The hammer descends by its own gravity, the force of the blow being regulated by the velocity with which the steam is allowed to escape from the cylinder; the emission of the steam being under the control of the attendant who has charge of the wheel, or other arrangement, by means of which the exhaust-valve is regulated. The eduction port is made of sufficient area to allow of the steam escaping suddenly from the cylinder when the whole force of the hammer-block is required.—*Glasgow Mercantile Advertiser.*

COMBINED STEAM.

A PAPER has been read to the British Association, "On Combined Steam," by the Hon. J. Wethered (America). He had been long convinced that Steam, as now used, was a very impure vapour, inasmuch as it contained a considerable quantity of water in the shape of small globules mechanically mixed with it in the process of ebullition, and taken with it to the cylinder of the engine. This water acquired its temperature, nearly up to the degree of vaporization, at a considerable cost of fuel, and with a great disadvantage, inasmuch as, from its lower temperature, it was constantly robbing the steam of its power by condensation, from the moment it passed from the surface water of the boiler until it left the cylinder, more particularly when the steam was under expansion in a vessel of a lower temperature than that of the steam—the result of which was, that the same pressure was never maintained in the cylinder as was shown in the boiler, and in many cases the annoyances of what was known as "priming" was experienced. His efforts had been chiefly directed to overcome this great and acknowledged enemy to the full power of steam. After trying superheated steam without success, he conceived the idea of combining ordinary steam—which by itself was too much saturated with water—with surcharged steam—which was of itself too dry—and he discovered in practice not only that the objections to both were removed, but that in "combined steam" a new power was produced, a distinct and new elementary compound, an effective and economical combination of fire and water, applicable to all purposes for which steam was employed, howsoever generated and howsoever applied. In addition to the usual steam-pipe which conveys the steam chamber of the boiler to the engine, he added another pipe, which conveyed part of the steam from the boiler through pipes which were convoluted or otherwise, and placed in any convenient form in the up-take or chimney of the boiler, and joined to the ordinary steam-pipe at or near its entrance into the cylinder. In its passage through these pipes this steam was more or less heated to a temperature of some 500° or 600° Fahr. by the waste heat passing up the chimney. This heat, thus arrested, was conveyed to and utilized in the cylinder of the engine by its action upon the saturated steam direct from the boiler, the combined steam *being worked in the cylinder* at temperatures varying between 300° *and 400° instead of at* the less temperatures at which it was now

employed. The paper then went on to show the experiments which had been made in the United States; and the results of these experiments, which were favourable, were stated in full detail.

THE AMERICAN CIGAR STEAM-SHIP.

THE designers of the American Cigar Steam-Ship have described this strange vessel in the *Illustrated London News*, but have overlooked a most important fact—viz., that the propelling wheel used by them will drive the ship sideways as well as ahead, and thus give her an oblique motion like that of a crab. The reason of this is obvious. Each blade of an ordinary screw propeller exerts what may be considered as two forces, one tending to advance the ship, and the other to move her stern laterally; but, as the whole screw is submerged, the transverse forces of the two blades neutralize each other, and the propeller is therefore effective in advancing the ship only. In the Cigar vessel, however, the propeller is but half-submerged, and the lateral force which each blade exerts as it passes under the vessel is wholly unbalanced, and free to produce its full effect in moving her sideways. It may be supposed by some that the employment of two wheels, side by side, and moving in opposite directions, would remove the difficulty. But it would not. They would have the effect of turning the vessel round about a point situated between the two wheels. The only efficacious method of propelling the vessel forward, and forward only, by such means, is that of employing three wheels, the middle wheel having a propelling surface equal to that of the other two, and turning in a direction opposite to them. The transverse forces of three wheels thus arranged would neutralize each other, and the vessel would be propelled ahead as the designers vainly expect her to be with the single wheel.—*Mechanics' Magazine*, No. 1843.

STEAM SLEDGE.

AT Irkoutsk, in Russia, a Steam Sledge has been invented. It consists of a locomotive and a carriage, the ice serving in place of rails. The inventor expected shortly to have the model completed, and to put two trains into regular service—one on the Amour road, and another on that of Moscow.

NEW AMERICAN STEAM-ENGINE.

THIS is the invention of Mr. Blanchard, of New York, who, on board the *John Gowan* steamer, has made an experimental trip up the Hudson River. The steamer was propelled by a steam-engine and boiler of this gentleman's invention. The water for the trip was contained in a tank, and the quantity consumed ascertained by measuration. The coal was weighed. The pressure was indicated by a steam gauge. In this manner the inventor made no statement, but simply showed what he did. The boat is 150 feet long, 24 feet beam, 250 tons measurement, diameter of paddlewheels 22 feet, length of buckets six feet, draught four and a-half feet. It is propelled by an ordinary beam engine, eight feet stroke, 36 inches dia-

meter, and by a high-pressure horizontal engine, two feet stroke, 34 inches diameter. The beam engine works at from 30 lb. to 35 lb., and is condensing. The high-pressure engine works at from 80 lb. to 100 lb. The steam escaping from it, at a pressure of 30 lb. to 35 lb., works the condensing engine. The boiler is tubular; the flame moves to the end of the boiler, and, returning near the furnace through small tubes below the surface of the water, hence it passes through two cylinder flues placed above the water into the steam. After leaving the boiler the flame is conducted around the tubes of several heaters in succession, and is finally let out perfectly cool, through a smoke-pipe six inches in diameter. The fireplace is closed air-tight. The air is forced in by a pump. The grate is higher in the centre, and goes slanting to the sides, like the roof of a house. At the top of the fireplace is a cylindrical opening, with double door or valve; the upper valve is opened, 50 lb. of coal are put in, and the valve is closed. The lower valve is then opened, and the coal falls upon the grate. The slanting shape of the grate is sufficient to make the coal thus falling dispose itself in a bed of even thickness. Over the smoke-box is the chimney; this is used only to light the fire, and to keep it burning while the boat is at rest; as soon as the vessel is under way, the chimney is closed by air-tight valves and used no more.

The new machine works as follows:—The steam from the boiler, at 90 lb. pressure, is made to pass through heater No. 1, where it is perfectly dried and expanded. Hence it works the high-pressure cylinder, is expanded by cutting off, and escapes at a pressure of 30 lb. through heater No. 2 to the low-pressure engine and the condenser. The feed-water is heated to the boiling point in heater No. 3 before entering the boiler. The air supplied to the fire is heated in heater No. 4. All the guests ascertained that 900 lb. of coal were consumed in getting up steam; that afterwards 1100 lb. of coal took the boat from New York to Haverstraw, a distance of forty miles. During the trip 357 cubic feet of water, equal to 22,311 lb., was transformed into steam. The steam passed into the cylinder at 30 lb. pressure, and a temperature of 330° Fahrenheit. The running time was three hours and six minutes. This engine consumes from 400 to 450 lb. of coal per hour. One of the same power on the common plan would require more than 1000 lb. Such a result is startling at first, but is easily explained. Each pound of coal requires for burning one pound and one-third of oxygen. Air is composed of four parts of nitrogen for one part of oxygen; and as only one-half of the oxygen of the air combines with coal burned in a furnace, it results that for every pound of coal burned at a grate nearly 12 lb. of hot gases escape through the chimney. These gases have to be at least of the temperature of 600° to produce a proper draught; sometimes they escape red-hot. Mr. Blanchard, by means of his heaters, recovers this enormous quantity of heat to raise more steam, and he produces the draught with a small fraction of the power thus saved. —*New York Tribune.*

STEAM-ENGINE BOILERS AND SMOKE PREVENTION.

An ingenious mechanic, named Thomas, of Chacewater, has invented the following valuable contrivances:—1. A Self-regulating and Self-supplying Boiler for Steam-engines, by which explosion is rendered next to impossible from inattentive feeding by the engineman in charge. By a clever but simple contrivance, the condensed steam is returned to the boiler in a hot state, thus causing a considerable saving in fuel. The model works admirably. Should actual experience on a large scale be attended by equally favourable results, a vast amount of difficulty will be overcome, especially where water of a corrosive or sedimentary nature only is to be procured. 2. A Smoke-condensing Apparatus: this we had an opportunity of witnessing at work. A fire was made in a closed stove, with coal smudge, to create as much smoke as possible. This passed through a horizontal chimney, to the annoyance of all present: half a minute after the contrivance was applied, not a particle of smoke could be discerned. The smoke was perfectly annihilated, and converted into matter, from which the inventor states he can manufacture gas of a very superior description, or can utilize as a manure of extraordinary value. He states that by the aid of four 24-in. cylinder engines he can free all London from smoke, and render the product of immense value. Two such engines would suffice for such towns as Birmingham or Leeds. The contrivance improves draught and circulation; the model certainly performs all this. Though we confess we are sceptical of the inventor's widely-extended views on the subject, still we believe it to be practicable, and to manufacturing towns and large cities an inestimable boon. They have both been patented.—*Mining Journal.*

EXPANSION ENGINES FOR STEAM-SHIPS.

There has been read to the British Association "A Description of Double Cylinder Expansion Engines for Steam-Ships," by Mr. J. Elder. These engines were constructed with the view of getting the greatest amount of power from a given quantity of steam at a given pressure. With such engines a steam-ship could steam the greatest distance possible with a given quantity of coals; a given distance could be performed in the shortest time, on account of the small weight of coals necessary to be carried; a larger amount of cargo and passenger accommodation was thus obtained; a less expensive ship was thus necessary, and the number of firemen and stokers would be also reduced. The cylinder capacity was so great as to admit of the steam being expanded to within 21 lb. of the pressure in the condenser at the end of the stroke, while the engines were working full power. In order to reduce the violent shock of high-pressure steam on such a large piston, a cylinder with a piston one-third the size was placed close to it. This small cylinder received the steam direct from the boiler during one-third of its stroke, and was then cut off. This steam was consequently reduced to one-third of its original pressure at the end of its stroke, and it

then entered the second cylinder, where it was expanded three times more. Thus 36 lb. of steam was expanded to 4 lb.—viz., from 36 lb. to 12 lb. in the first cylinder, and from 12 lb. to 4 lb. in the second; but as the second piston was three times the size of the first, the load would be the same on both pistons, and the piston-rods, cross-heads, and connexion-rods might be duplicates of each other. The steam and eduction slide valves were wrought with eccentrics, the steam valve was a gird iron with large lap, the eduction valve which served for both cylinders having no lap at all. The eductions remained open during the entire stroke of the piston, thereby giving a free egress for the steam, and ample escape for water, should it form. The cylinders were steam jacketed, and then covered with felt. There was a small engine pump for forcing the distilled fresh water from the jackets, or into the freshwater tanks, if necessary. The boilers were tubular, with three large super-heating uptakes, two feet in diameter, and fifteen feet in height, leading up through an oval steam-chest to the funnel. The feed-pipe of the boiler had twelve spiral convolutions inside the funnel to heat the feed-water; this might be shut off when desirable.

As to the economy, several gentlemen could certify that the engine had been thoroughly tested and found successful. During the run from Glasgow to Liverpool the consumption was 2·98 lb. per indicated horse-power per hour of a large steamer called the *Valparaiso*; while a smaller steamer called the *Bride of Erin*, having the same kind of flue, boilers and machinery, consumed, during 5½ hours, 4·27 lb. per horse-power per hour. In both cases the surface blows were open, and other circumstances duly considered. Mr. Elder added, that the ships he had furnished, on coming home to be refitted, would return with 30 feet space gained amidships for passengers and cargo, in consequence of the saving of room by reducing the necessity of boiler and coal space, and that the vessels were expected to consume 500 tons less on the voyage, and the ship would have 20 per cent. more accommodation, which of itself was valuable.

SEWARDS' PATENT BOILER FOR HEATING AND CIRCULATING WATER.

MESSRS. A. and C. SEWARD, of Lancaster, have patented this improved Boiler, formed by combining two similar upright castings with sets of horizontal pipes, as follows:—The upright castings are formed hollow, and with a number of sockets, into which are cemented the ends of a corresponding number of horizontal pipes, the length of which determines the capacity of the boiler. Of these pipes there are two side-sets, in each of which the pipes are arranged one above another, and three transverse sets, in each of which they are arranged side by side. The castings are also furnished with suitable inflow and outflow pipes. The fire is placed upon the lower set of transverse pipes, and the flame and hot gases from it pass between *the lower and the* middle set,—the spaces between the pipes

of the middle set being closed up,—return to the front between the middle and upper set, and again pass to the back above the upper set, finally passing off by the chimney. The ends of the several sets of pipes open into the hollow castings, and the water, as it is heated, is compelled to circulate through the pipes and castings, and away through the outflow pipe or pipes.—*Mechanics' Magazine*, No. 1809.

STEAM-BOILER EXPLOSIONS.

MR. J. HOPKINSON has communicated to the British Association, a paper "On the Cause of Steam-Boiler Explosions, and Means of Prevention." After alluding to the frequency of explosions, and sketching the history of Boilers from the time of Savery and Newcomen down to the present time, when the double flue or the double fire-box boiler was the fashion, he condemned this latest and most popular invention as unsafe. He next sketched the various causes of explosion. These were—over-pressure, with water at its proper height, caused by the safety-valve being inoperative, inefficient, or miscalculated; over-weighting of the safety-valve; deficiency of water; and admittance of cold water when the boiler is over-heated. To prevent explosions he had designed a compound safety-valve, which could not get out of order, which accurately registered the true state of affairs inside the boiler, and which combined all the best principles of the most approved safety-valves now in use. Mr. Hopkinson then described fully and technically, the peculiarities of his compound valve.

STEAM-BOILER MACHINERY, AND STEAM-ENGINE TOOLS.

PAPERS have been read to the Institution of Civil Engineers, "On Shearing, Punching, Riveting, and other similar Machinery employed in the Manufacture of Steam Boilers," and "On the Self-acting Tools employed in the Construction of Steam-engines, &c.," by Mr. T. S. Sawyer. A brief description of the machinery for forging rivets, &c., was given, and by one example it was shown that a ton of well-formed rivets, all exactly similar, could be produced in ten hours. The machinery for forging bolts, and other similar articles, was then described, together with the various arrangements of air-hammers suitable for larger work; the principal feature of which consisted in allowing a hammer, or block, to fall by its own gravity against the pressure of air in a cylinder, so as to produce an elastic blow. In the discussion, it was remarked that Mr. Richard Roberts had been one of the earliest introducers of self-acting tools, such as the planing, slotting, and machines for metals. Within the last few years he had also made improvements in punching and riveting machines. His "Jacquard," or multifarious perforating machine, was now employed at the Canada Works, Birkenhead, for punching the boiler-plates to be used in the construction of the Victoria Bridge over the river St. Lawrence, Canada. The machine was now punching seventy-two holes in each

plate of 10 feet in length, and 3 feet 6 inches in width, and 5-16ths of an inch in thickness. It could punch ninety of these plates per day of ten hours and a-half, under the management of one mechanic, three labourers to lift the plates on and off, and one boy to oil the punches. The same sized plate, when punched by hand, would require four men marking with templates, and eight men at the machine itself, and yet it would not do anything like the same quantity of work as the Jacquard machine, especially when a large number of holes had to be made.

STEVENS'S REGULATING AIR-DOORS.

THE following Official Report has been made to the Corporation of the Trinity-house by the chief engineer of the Trinity steamship *Argus*, relative to the ascertained results from the use of the patent Regulating Air-doors fitted to her steamboiler furnaces by Mr. John Lee Stevens. The Report testifies to the success of the patent:—

"In compliance with the order of the Committee for Lights, I beg to state, in my previous report on Mr. Lee Stevens's patent regulating air-doors fitted to the boilers of the *Argus*, I stated that the invention prevented the emission of flame from the tops of the funnels, and thereby materially diminished the heat therein, and that the engine-room was better ventilated. I have now to report that, after repeated trials and weighing of different sorts of coal for many hours at each time, a saving of fully 10 per cent. is the result for Welsh coal, and for Hartley coal a saving of fully 20 per cent., at the same time keeping good steam and the smoke cut off very quick. I would also state that, from the first fitting of the patent doors eight months ago to the present time, no injury whatever has been done by the action of tho fires to the apparatus."

STEAM-CARRIAGES ON COMMON ROADS.

MR. SQUIER has communicated to the *New York Herald* a lengthy account of the progress of this invention in New York, whence we select the most important details. The Steam-carriage, which has been propelled through the streets of New York for some time past, was invented by Mr. Richard Dudgeon, a mechanic, of English birth, but who learned his trade in America. He is the inventor of the portable hydraulic jack, which is well known to steamboat men, and also of other minor applications of hydraulic power. Mr. Dudgeon's carriage weighs 2700 lb., and may be described as a half or quarter-sized locomotive, with very large wheels and no smoke-pipe. It has no peculiarity in the arrangement of the steam machinery, which is a simple tubular boiler, with improved valve gear. The cylinders are fastened to the front of the boiler or smoke-box at the usual angle, and have inside connexions to the crank. The steam is distributed to the pistons by a modern slide valve, and the link motion perfected by Stephenson. The steam and smoke are discharged downwards, in front, without a chimney, and pass behind a water-tank on the front end of the boiler. The cranks are worked on the inside instead of the outside, as in other locomotives. The improvement over other engines consists in increasing the stroke of the piston, and diminishing the size

of the driving wheels. The stroke is eighteen inches, and the diameter of the wheels three feet and a half. The carriage wheels are very similar to those in ordinary use, only smaller, to diminish the jolt. The hind axle, to which the steam power is applied, is an ordinary crank axle. The steering is done by the front wheels, and with great ease and certainty, there being no difficulty in passing through the most crowded streets in New York. The steering is accomplished by a stout iron rod, armed with a screw at one end, which moves the front axle according to the direction it gets from the cranks, and is under the control of the driver, who sits behind the boiler. The axles are at either end of the boiler, so that it may be kept low and a long wheel base obtained, which makes it run very steady over a rough pavement. It is not pretended that this carriage will run on a soft road; its great weight (2700 lb.) would render it impossible to make any progress. It is imperative that the road should be hard and even; and should these vehicles ever come in use, roads must be made for their accommodation. An ordinary tram-road—that is, boards laid lengthways, for the wheels to run upon—would, the inventor claims, do very well for all practical purposes. The carriage also travels very readily on an inclined plane. The inventor claims that it will easily ascend a hill 600 feet per mile, and there is reason to believe that it will do so. From the speed attained, it is evident that twelve miles per hour could be run easily, provided all was in condition, clear, hard road, &c.; and this, of course, leaves a margin for improvements in the construction of other steam vehicles. The cost of the machine under notice is 1500 dollars; it requires two persons to manage it; a lad, however, is quite as competent as a grown person for this duty.

STEAM AGRICULTURE.

A PAPER has been read to the Society of Arts, "On the Application of Steam Power to the Cultivation of the Soil," by Mr. J. Algernon Clarke. Leaving the application of steam power to what might be termed the mill-work of the farm, such as thrashing, cutting, grinding, &c., Mr. Clarke directed attention to the operations in the field, and chiefly to that of breaking up the soil, and the preparation of the seed-bed, these being the main objects to be accomplished in steam cultivation. He proceeded to review the existing implements, observing that there was no doubt that a steam-plough was capable of instant and universal adoption; he referred specially to the traction-engine, the proposed system of "guideways" or rails—the expense of which would, he thought, prevent their adoption—and also to the windlass and rope as a means of transmitting power from the engine to the implement. Under ordinary circumstances he thought that the adoption of the shifting engine and windlass, moveable along the headland, was one of the best steps taken for cheapening the operation of steam-ploughing. He concluded by briefly alluding to the recently proposed methods of digging the ground by rotatory implements, and described a plan of his own invention for carrying this out more effectively.

There has also been read to the Society of Arts, a paper "On Guideway Agriculture, being a System enabling all the Operations of the Farm to be performed by Steam Power," by Mr. P. A. Halkett. This system consists in the application of motive power to the cultivation of the land, by attaching the implements for cultivation required for the various operations of ploughing, scarifying, sowing, hoeing, reaping, or other operations of culture beneath a travelling carriage, which moves on rails placed in parallel lines across the fields to be cultivated, by which the implements are always kept from swerving to the right or left of the line of onward motion, and the friction of the machinery is considerably reduced. The cost of machinery and implements is stated at the same as that of horses and horse implements required for the same work; the laying of rails to amount, according to the wood system, to 10*l.* per acre; and the brick and angle iron system to 20*l.* per acre.

FOWLER'S STEAM PLOUGHING APPARATUS.

MR. JNO. FOWLER, who recently obtained the Agricultural Society's prize for steam ploughing, has completed a patent for the use of two steam-engines mounted on separate carriages to haul ploughs and other agricultural implements in such a manner that the power of the two engines is applied at the same time to give motion to the implement. For this purpose, two engines, each furnished with a pair of grooved drums, one or both driven by the engine, are placed opposite to each other, one on each headland, and an endless rope passes from one engine to the other, and takes two or three turns round the drums of each engine. The implement is attached to the rope, and is hauled by means of it backwards and forwards over the land between the two engines, according as they are working to wind the rope in one or other direction. The engines traverse along the headlands as the work progresses, and the length of the endless rope is adjusted according to the distance between the engines by winding or taking up a greater or less length of it by means of a drum or apparatus carried by the implement. In this manner the patentee is enabled to use engines of half the power of those which it is necessary to employ when the implement is hauled in both directions by means of one engine, or when it is drawn by two engines on opposite headlands working alternately; and these engines of smaller power are most useful for other farm purposes.

AMERICAN PLOUGH.

MR. H. M. PLATT, of New York, has completed a patent for a novel form of Ploughing and Tilling apparatus, the object of which is to turn the soil and pulverize it at one operation. The invention consists in substituting a revolving screw-shaped share for the ordinary one. This revolving share is so coupled and geared to a wheeled carriage, that as the machine advances, the screw-shaped share enters the ground and lifts the furrow slice, which is completely cross-cut as the share revolves, so that the soil is thoroughly pulverized and left fit for the immediate planting of seed. The invention seems to

solve the problem of steam cultivation, by getting rid of the hard pan at the bottom of the furrow, which was consequent upon the action of the share passing over the ground, and formed a chief ground of objection to the extension of the use of the ordinary plough with steam.—*Critic.*

STEAM TRACTION ENGINES.

SIR FREDERICK ABBOTT has reported to the East India Company upon an engine by Boydell, working under a steam pressure of 120 lb. per inch, and calculated at 37-horse power. Having been constructed for agricultural purposes, and in the most economical manner, it drives only one wheel (the off wheel). At the Royal Arsenal it took in tow four guns, two mounted on ordinary, two on devil carriages, the whole load being estimated at about 43 tons. This load it drew at the rate of about three miles per hour on level ground, and at about two and a quarter miles up a steep hill, part of which was inclined 1 in 13. Its power of draught was very great, but owing to its driving only one wheel it was unmanageable with a load, as it could scarcely be turned to the right hand. The experiment, as far as regards this individual engine, for general purposes of draught, was a failure; but the powers and capabilities then exhibited, and on previous trials, induce Colonel Abbott to hope that when the machinery shall be perfected to work both wheels together, or either wheel singly, an engine thus constructed and equipped with a train of carts, of a peculiar though simple form, would be able to traverse any country where an ordinary bullock-cart could travel; and, being able to move continuously at the rate of three and a half to four miles per hour, would perform journeys of little less than one hundred miles in twenty-four hours. An establishment of such engines and carts would enable Government to dispense with half the ordinary military force in India, seeing that troops could then be concentrated in one-fifth the time required by even "forced" marches. Such self-acting railways, though immeasurably inferior in speed to fixed railways, will be more generally useful for military purposes, as they will travel in any direction, and will be safe from the designs of enemies.

The novel expedient of transporting heavy ordnance by means of a newly-patented Steam Traction Engine has also been tested at Woolwich. This engine is the invention of Mr. Bray, an engineer of Folkestone, and differs from that of Messrs. Boydell merely in the construction of the hind wheels, which are supplied with a broad hoop instead of the endless railway, and which affords sufficient bearing on the ground to support the weight of the engine over ordinary roads. The wheels are fitted with blades of iron, which serve as teeth or claws, and are of great assistance in travelling over hilly roads. The teeth are applied by a mechanical power termed "an eccentric," so as to move in and out and clear themselves of any soil with which they may be encumbered, and which enables the teeth to be entirely drawn in or distended to any requisite extent. When turning, or going round a curve, the wheel on the inner side

is disconnected, while the outer wheel is kept in gear, and the engine is thus enabled to turn with facility. It was, in the above experiment, charged with a 68-pounder gun, weighing 112 cwt., which it conveyed through the gates of the Royal Arsenal, down the Plumstead-road, over the steep acclivity of Burrage-hill, returning by the descent of Sandy-hill to the Arsenal. The speed of the engine rarely exceeded two and a half miles per hour—about the average pace of a carthorse—but it continued a similar pace against the breast of the hill. The descent was likewise cleverly arranged, the engine appearing to be under the most perfect control of the helmsman and engineer.

STEAM RAMS.

A CORRESPONDENT of the *Times* attributes this employment of steam to a rich merchant in America, named Stephens, who, having suffered serious losses by collision of his vessels with others at sea, conceived that the tremendous force of steam power might be turned to account in naval warfare, in the same way. He then commenced constructing a Steam Ram: the steamer was to be shot-proof by means of iron plates, and since then the manner in which those plates resist for hours the heaviest shot, has become notorious. It was to be the largest steamer afloat, and it was to travel at the rate of twenty knots an hour—that is to say, faster than ocean steamers, though not so fast, for instance, as Her Majesty's yacht. It was to be propelled by six powerful engines, to be sharp at the bow and stern, being a bed of iron at both extremities, carrying one monster gun, and a heavy, but not numerically strong, armament, after the *Merrimac* model. Such a vessel would be a fearful antagonist for even a fleet of three-deckers to meet with on the wide ocean, and all she would have to fear would be being laid aboard. To prevent this, she was to throw streams of boiling water from her sides, so as to be unapproachable. The enterprise gradually progressed, but Mr. Stephens did not live to see it completed, although he was fortunate enough to have his conception approved by his country: after his death, his expenses were refunded, and the American Government carried out his idea. This mammoth naval ram is now nearly finished, a yearly sum having been allotted to the work.

A similar engine, called the "vaisseau-bélier," or steam ram ship, is also in course of construction at Cherbourg, first said to have been designed by the Emperor of the French, but now believed to have been copied from a design submitted to the French Minister during the Russian war by Vice-Admiral Sartorius, who has also published his views on the subject.

Another Correspondent of the *Times* (M'Ivor Campbell, Arknish, Loch-gair House, Inverary), however, states that so long ago as November, 1852, he addressed three communications to the Lords Commissioners of the Admiralty, explanatory of his then projected "steam ram," to be manned only by an officer, engine-men, and helmsman, with means of escape, if necessary, after this huge iron ram should have been *plunged into the body* of an enemy's ship; and on the

24th of that month transmitted to their Lordships a drawing with a full description of the structure, mode of appliance, capability, and general effect upon our present system of naval defences.

It appears that Admiral Sartorius, by permission of Sir Charles Wood (then First Lord of the Admiralty), communicated his views to the French Minister, which appears to be an odd way of getting rid of the subject, but quite in keeping with the official apathy and love of irresponsibility at the Admiralty. Admiral Sartorius designates his vessel the "shot-proof steam ram," and suggests the addition of various armaments and appliances, which do not, however, touch on the actual source from which the original idea or first principle may have flowed. On this point Mr. M'Ivor Campbell thinks he has a fair claim, not only on the respected and gallant Vice-Admiral, but also on the candour and justice of their Lordships of the Admiralty, who have had his project of "steam rams" in their possession for nearly six years.

Mr. Campbell considers his invention would prove a powerful, effectual, and inexpensive weapon, equal in itself to all emergencies that may threaten our coast.

A small flotilla of steam rams in every harbour would, at a very short notice, be ready and able to sink any invading fleet; his original proposition being that these rams should operate in concert, always attacking from different and opposite points, so as to render the escape of an enemy hopeless, and his immediate destruction inevitable. To encumber these rams with forms and appliances suitable to ocean purposes would greatly deteriorate, if not destroy, their peculiar efficacy.

In addition to the above communications, Sir Charles Fox has stated that Mr. James Nasmyth, about thirteen years ago, independently invented and promulgated everything that has since been re-proposed as to steam rams. Next, Mr. Mallet, C.E., traces back the invention or proposal to a still earlier date and inventor.

About the year 1835, or twenty-three years ago, Captain Richard Bourne, R.N., while managing director of the old Dublin and London Steam Navigation Company in Dublin, frequently and publicly promulgated his views of the use of steam rams, that should (as he expressed it) "break any ship-of-the-line like an egg-shell." And upon one occasion he fully detailed his notions of constructive detail to Mr. Mallet, and to the late Mr. Francis Humphreys, then marine engineer to the Company; and Mr. Mallet thinks that Captain Bourne about that time also communicated his views to the Admiralty, thus charging "my Lords" with the omission at a still more remote date than above mentioned.

If these several statements be correct as to dates, how strange it is to find America and France at this moment expending vast sums upon a war invention, the secret of which, nearly a quarter of a century since, was in the possession of our own Government!

THE PADDLE AND THE SCREW FROM THE EARLIEST TIMES.

A PAPER of great value and interest has been read to the Society of Arts, by Mr. John Macgregor, M.A., describing the Paddle-wheel and Screw-propeller, from the earliest period to the present time. The information contained in this paper was collected by the writer in compiling, for the Great Seal Patent Office, the "Abridgments of the Specification of these Patents." The *abridgment* of Mr. Macgregor's valuable paper occupies six large, closely-printed pages, illustrated with woodcut diagrams of curious modes of marine propulsion, which were exhibited during the lecture. Its chronological data and illustrative notes are very suggestive: we have only space to quote the conclusion:—

"In the modes of propulsion adopted by aquatic animals, (says Mr. Macgregor,) may be found almost every plan which has been used by man with machinery. Thus, water is ejected by propulsion by the cuttle-fish and paper-nautilus; sails are used by the velella and water-birds; punting and towing by whelks and the lepidosiren; a folding paddle by the lobster; feathering paddles by ducks; and oblique surfaces by fish of all kinds. A screw-like appendage is found in the wings of an Australian fly; but it is supposed to be shaped thus only when dried after death. There is, however, one remarkable animal which propels itself by a rotary movement, acting on the water by means very similar to those of the paddle-wheel and screw-propeller combined. This is the infusorial insect Paramecicum, in which a furrowed groove runs obliquely round the oval-shaped body of the animal. A wave-like protuberance passing along this groove, (with or without cilia,) causes the body to rotate on its longer axis, and thus propels it as by the fore-and-aft stroke of a paddle, as well as by the screw-like progress induced by the spiral groove."

The coloured diagrams exhibit the gradual progress of Marine Propulsion from the early days of Nineveh, Babylon, and Egypt.

At the close of the lecture, Mr. Scott Russell, the chairman of the evening, very pertinently inquired that "of hundreds of inventions that had passed through Mr. Macgregor's hands in the extensive research he had undertaken in preparing this paper, were they not amazed to see how few were at this day in practice; and were they not struck with the fact that nearly all the inventions they now heard of no more seemed monstrously ingenious, whilst the inventions actually in use were those which appeared to have got rid of all the ingenuity, and to have merely retained one or two plain, simple, common-sense elements in them! Now, that was the lesson which he would wish Mr. Macgregor's paper to have taught to his audience, especially the younger members; and that was the lesson he hoped it would teach to the mechanical world at large in the wider sphere of its influence when published in the *Journal* of the Society."

The Abridgments of Patents by Mr. Macgregor have been completed by *the publication* of the Third Part:—

In Part I. is a summary of the principal British and foreign inventions re-

lating to the propulsion of vessels. These are arranged chronologically, with Abridgments of the Specifications of British Patents, to the end of A.D. 1830. In Part II. will be found Abridgments of the Specifications of all the British Patents on the subject, from A.D. 1831 to the end of A.D. 1847, together with a few notices of unpatented inventions and of experiments. In Part III. are given the Abridgments to the end of A.D. 1857; also an Index of Names, and an Index of Subject Matter referring to all three parts of the work.

Mr. Bennet Woodcroft, in the Preface to Part II., observes:

"It is not the object of this work to compare the merits or originality of the inventions recorded; but in one or two instances of special importance and of national interest, the evidence for and against particular claims has been briefly considered. It must also be borne in mind that these publications are not prepared with a view to their being used to explain doubtful descriptions of an invention: the complete specification being still the only true guide to the inventor's claims.

"By consulting the Index of Subject Matter in this and the preceding Part, it will be observed that several important inventions have been brought forward over and over again as entirely new, at various intervals of time, and it is evident that this might have been prevented, had there been brief and clear records published of everything proposed before.

"It is hoped, therefore, that the publication of these abridgments will prevent the misapplication of time and labour in the operation of re-inventing what is already known, and by recording the experience of the past will direct the energy of the ingenious to improve upon old plans, and to exercise themselves in new fields of labour."

SCREW PROPULSION TESTIMONIAL.

A VERY interesting commemoration of the success of this important invention took place at St. James's Hall, Piccadilly, on June 2, 1858; when, at a Public Dinner, Mr. Robert Stephenson, M.P., in the chair, a Silver Salver and Claret Jug were presented to Mr. Francis Pettit Smith, "by the Committee and other subscribers to the Smith Testimonial Fund, amounting to 2678*l.*, as a record of their high estimate of his private worth, and the great benefit conferred by him on his country, in introducing, and by his talent, energy, and perseverance, bringing into general use, the System of Screw Propulsion, which is already employed in the following vessels of Her Majesty's Fleet." Here follow the names of 52 line-of-battle ships; 23 frigates; 17 corvettes; 55 sloops; 8 floating batteries; 19 troop and store ships, making a total of 174 of Her Majesty's ships which have been fitted with the Screw Propeller. Then follow the names of the 138 subscribers, chiefly eminent naval officers, engineers, ship-builders, ship-owners, and men of science. With the Plate was presented an Address, beautifully engrossed on vellum.

This was altogether a most impressive Festival. The Plate was presented by Mr. R. Stephenson, after a lucid view of the value of Mr. Smith's services; to which that gentleman briefly replied. Mr. Scott Russell, one of the vice-chairmen, in the course of the evening, illustrated historically, and with great judgment and felicity, the respective shares of the engineers, ship-builders, and others, who, from time to time, have contributed to the adoption of Screw Propulsion, consummated by the services of Mr. Pettit Smith. To distinguish the relative claims of the inventor was no easy task; and we have rarely seen a difficult subject so judiciously handled as it was,

upon this occasion, by Mr. Scott Russell. Other gentlemen illustrated the subject of the evening, which was most intellectually passed, as one of the speakers observed, in commemorating "one of those bloodless triumphs of civilization of which this age and country have just reason to be proud."

LOSS OF SHIPS AT SEA.

To remedy, in some measure, the painful suspense into which multitudes are thrown by ships missing, a gentleman, Mr. John Gresham, has proposed to the British Association that every vessel should be provided with one or more copper buoys bearing her name and the port to which she belongs; that these buoys should also have an Admiralty mark, and a Board of Trade number; and that each should be provided with a chamber with a small spring valve made to open outwards, and capable of resisting any pressure, which should be used for receiving letters, or even treasure; so that if the ship were lost, the buoy would float off in safety, and the information it contained would be communicated to the parties interested by any ship which might pick it up. The buoy is intended to be made of strong copper painted in bright red and white stripes, and to be fitted with a small bell and flag on the upper part.

NEW SAFETY LINE CARRIER.

M. Bertinetti, of Turin, has patented in Piedmont, France, England, &c., an apparatus consisting of a wooden shot, to which a line is attached, and which is propelled by a feeble charge from a gun on board the ship or on the shore. The inventor says that Manby and others have never been able to throw their lines more than about 200 yards, but that his can be thrown four times that distance. Letters are subjoined from the French Minister of Marine, and from the Minister of Commerce. The former, Admiral Hamelin, says, that the French Government has aided him in making his experiments, and perfecting his invention. The apparatus has been found capable of successfully establishing a communication between the vessel and the shore, at a distance of 400 yards, from whatever point it is thrown; and the inventor has supplied the French Government with twenty new shots, in addition to the nineteen already in their possession, "not so much to provide for those rare cases in which Government ships need such assistance, as to reward the inventor, and help to defray his expenses."

PATENT SLIPS FOR SHIPS.

Heretofore, in constructing slips, it has been usual to arrange them, and the apparatus connected with them, so that the ships to be raised may be received and moved up or down thereon with their keels parallel to the lines or ways of the ships. Mr. Scott Russell has patented certain improvements upon this method, consisting in combinating the slips and apparatus, so that the keels of the ships to be *raised or moored* may be received on them transversely, or *across the fixed ways or rails*; and where the extent of frontage is

considerable, it is desirable to construct the carriages used to receive the ships of several parts, each capable (by its chain and capstan, or their tackle, or other mechanical contrivances used therewith) of being moved up and down the fixed ways or rails, and also of being used conjointly with other carriages when the length of the ship to be received and moved requires the combined use of several.

NEW MODE OF ACCELERATING THE SPEED OF SHIPS.

MR. F. GRIFFITH, of London, has patented a form of construction, by which the immense amount of resistance encountered at the head of ships and steamers can be turned into a counteracting power, instead of being, as hitherto, all sustained as dead loss. The theory has been warmly discussed in several numbers of *The Engineer*; after which the author of the paper professes to have tested the efficiency of the contrivance by a series of experiments, and found them to be perfectly conclusive of the soundness of the resistance-counteracting principle. The method consists of a revolving conical bow, around which are wound spiral flanges. The resisting water (when the ship is in motion) impinges upon the flanges, and causes the cone to revolve. The force thus attained is transmitted by shafting and multiplying gear, to work a screw at the stern, if a sailing vessel, or to go in aid of an engine, if a steamer. In the experiments made, when a string was attached to the cone shaft of one of the models, it invariably wound itself up against a stream; and it is argued that, as a power cannot be obtained from nothing, it is abstracted from the total resistance.

MANAGEMENT OF SHIPS' BOATS.

MR. C. CLIFFORD has patented certain improvements in ships' davits, and in apparatus for stowing, lowering, and securing boats. Here, for raising and lowering boats, a single davit having two heads is used. This davit consists of an upright pillar carried by bearings at the ship's side, and furnished with two arms, which, as they spring from the pillar, make an obtuse angle one with the other. The arms at their ends are fitted up like ordinary davit heads, and are stiffened by ties running to the top of the central pillar. By using a davit of this construction a boat may be turned from outboard inboard, and *vice versâ*, simply by causing the pillar of the davit to make a semi-rotation in its bearings.

NEW BELL BUOY.

A NEW BELL BUOY has been invented by Mr. Whettem, the son of the master mast-maker in Portsmouth Dockyard. The buoy appendages invented by Peacock and others for the purpose of warning the mariner of his proximity to danger, have this serious disadvantage—the hammers used to strike the bell remain upon it for a short space of time, thus stopping that vibration which is so necessary for the production of a clear ringing sound. Mr. Whettem's plan is devised to obviate this difficulty. The hammers used by him are two quadrants so fixed as to strike the bell alternately, as the buoy

to which it is affixed is set in motion by the action of the waves. The necessary motion is given to the quadrants by a shot traversing a cylindrical chamber, and by its momentum striking the lower end of the quadrant with sufficient force to make the upper end strike the bell; but immediately upon doing so the quadrant returns to its original position, the centre of gravity being below the point of suspension. On the return of the shot to the other end of the cylinder, a similar action takes place with the other quadrant, and so on continually. The result is a loud and clear ring, which can be heard much farther than the sound of any other bell. It has also the advantage of giving its warning note to the seaman even when the motion is no more than that caused by the roll of the sea. This would render it invaluable in foggy weather. A model of the invention has been inspected by the Admiral Superintendent, and other officers of the dockyard and of the Navy, all of whom express their unqualified approval of the arrangement.

The striking action of the bell is singularly active, the least rolling motion given to the buoy producing a blow of the hammer against the bell; the blow, too, being given with so much smartness as to bring out the fullest sounding powers of the bell.—*Mechanics' Magazine*, No. 1828.

MAHOGANY SHIPS.

In consequence of the increasing scarcity of good oak timber for ship-building, the use of Honduras mahogany as a substitute has lately very much increased, both in England and other parts of Europe. M. Arman, the well-known ship-builder at Bordeaux, in 1857, made some experiments to ascertain the strength of mahogany as compared with French oak and teak. A piece of each kind of wood, about four inches square, was placed across the machine used for proving chain cable, and a piece of chain was attached to a ring fixed in the centre of it. A strain being laid on, the oak broke under a force of 1800 kilogrammes; the teak with that of 3300; and the Honduras mahogany of 3400. The oak and teak appeared as if crushed, but without a complete disjunction of the fibres; the mahogany showed long splinters, indicating a much longer grain or fibre than the others. M. Arman considers this result as a conclusive proof that mahogany is superior for many kinds of ship-building purposes, though it is less flexible than good French oak. MM. le Mire and Son, builders at Rouen, give the result of using mahogany in a vessel which they had built, the *Adèle*, just returned from a long voyage. The captain, in a letter to the builders, gives a most satisfactory account of the state of the vessel, and expresses his decided opinion that the use of oak in ship-building may be advantageously replaced by mahogany.—*Builder*.

CAST-STEEL SHIPS.

In December, 1850, Mr. Ewald Riepe obtained an English patent for certain *improvements in refining* steel, which consisted mainly in *subjecting bars or lumps of* raw or crude steel to the action of heat for

about four hours in a furnace closed to the external atmosphere, the temperature being kept a little below the melting point of the steel. By this method of operation, carburetted hydrogen and oxide of carbon are developed in the furnace in abundance; while the oxygen of the air is entirely prevented from acting upon the steel, the working door of the furnace, &c., being carefully luted for this purpose.

This patent, which was permitted to remain in abeyance for some time, has lately been worked with very beneficial results by Mr. William Clay, of the Mersey Ironworks; the steel produced by means of it having been found to possess a very fine uniform grain, and to be peculiarly suitable for the plating of ships. A new steamer of 170 tons, named the *Rainbow*, intended for the Niger expedition, has been constructed of plates of this steel at the building yard of Mr. J. Laird, of Birkenhead.

This new vessel is described as a smart, rakish-looking screw steamer, sailing smoothly and rapidly, her steam-pipe emitting the energetic snort peculiar to a railway locomotive, proving that she is fitted with a high-pressure engine. Her dimensions are:—Length, 130 feet; beam, 16 feet. The hull is subdivided, by athwartship and longitudinal bulkheads, into ten or twelve water-tight compartments, for the purpose of giving greater strength and rendering her more secure against accidents. The high-pressure engine is of 60-horse power, working up to 200-horse power, indicated; and the boilers, which have also been made of Mr. Clay's puddled steel plates, have been proved up to 200 lb. on the square inch, though they will only require to be worked at 50 lb. to 60 lb. The engine and boiler, as well as the hull, have also been constructed by Mr. Laird. The advantage of employing this material over the ordinary iron plates is that, with about half the thickness, they give equal strength with the best iron boiler plates, so that vessels of considerably lighter draught of water are able to be constructed than formerly, a result which is likely to be of incalculable benefit in the navigation of the shallow rivers of Africa and India. It will be remembered that Dr. Livingstone took out a small steam yacht, the plates for which were formed of the patent homogeneous metal, manufactured by Messrs. Shortridge, Howell, and Jessop, of Sheffield. The advantage claimed for the puddled steel is that, while possessing equal strength and adaptability for the purposes of ship-building, it can be more economically produced. Indeed, it is said of the puddled steel that the process of manufacture is so simple, and the cost so little in excess of that of ordinary iron, that, by the saving of weight in the material, as compared with iron of equal strength, it will become absolutely cheaper. *Apropos* of the strength of this puddled steel, we may state that recent experiments made by Mr. Clay in testing, at the Liverpool Corporation chain-proving machine, some samples of puddled steel bars manufactured at the Mersey Works, showed that their average tensile strength was 160,832 per square inch, while the strength of Russian iron is only 62,644; of English rolled iron, 56,532; Lowmoor, 56,103; American hammered, 58,913; of tempered cast steel, 150,000, &c. The trial trips have proved highly

successful, the average speed attained being twelve to thirteen miles per hour, while there was almost entire absence of vibration, which is especially noteworthy of a vessel constructed of steel plates of only one-eighth of an inch thick. She had all the stiffness and rigidity of a strong ship, and her performance was declared to be exceedingly satisfactory.

A yacht has since been built of puddled steel, the same as those used in the *Rainbow:* she is 96 feet long, 16 feet 6 inches beam, has a tonnage of 131, and is supplied with a high-pressure engine of 25-horse power. It is intended as a pleasure-yacht for the Duke of Leeds, is named the *Deerhound*, and has excellent saloon accommodation for his Grace and friends, with good space for captain, engineer, and crew. She is fitted with a lifting screw, is rigged as a schooner, and, from her fine lines and beautiful model, is expected to prove a very fast sailer as well as steamer. Great credit is due to the Duke of Leeds for being the first to introduce the new material of puddled steel plates in the building of yachts—an example which will, no doubt, be largely followed.

The use of steel (says the *Mining Journal*) appears likely to become pretty generally employed in place of iron—an equal strength being obtained with much less weight. On the Mersey four steel vessels are building, and on the Clyde five. In all cases where a light draught of water is a desideratum, steel has undoubted advantages, and the manufacture of cheap steel should therefore be encouraged to the greatest possible extent.

FLOATING AND FIXED BATTERIES.—IRON ARMOUR PLATES.

MR. GEORGE RENNIE has communicated to the British Association a paper "On the Construction of Floating and Fixed Batteries." It was now some years, he said, since the covering of the exterior of vessels of war with plates of iron was proposed by General Paixhans, of the French Artillery. This he exposed in his work, and stated that to enable a plate to resist a 32 lb. shot, it would require a thickness of several inches, and that from the great weight of the plates it was only applicable to ships of the line, and that at a cost of 24,000*l.* On the commencement of the late Russian war, the Emperor of the French, who had paid much attention to the subject, brought it before our Government. He considered it would very much facilitate the operations then about to take place against the Russian fortresses of Bomarsund, Helsingfors, Sweaborg, and Cronstadt. Vessels of great burden and strength were therefore constructed and covered with massive wrought iron plates of four and five inches in thickness. The results of the few trials which were made with these iron-plated batteries were published in the journals of the day, but their success was considered to be doubtful. Many experiments of solid and hollow shot, fired from 68 lb. guns, have been made recently at Woolwich and Portsmouth, with unfavourable results. These results led the author to think that little or *no success had hitherto* been attained. He therefore *proposed to use inclined* or curved surfaces, instead of flat or point-

blank surfaces, as was illustrated in the models exhibited. One of these was a floating-battery, or man-of-war, having its sides cased with iron plates with curved surfaces; the other of a fixed or floating-battery, also with curved surfaces. He claimed no other originality for this idea than in the curved forms of the plates. Mr. Rennie also exhibited various specimens of felt which had been handed to him by General Sir Charles Shaw, and several of which had been penetrated to a limited extent by rifle balls.

Captain Fishbourne was of opinion that with such an extreme weight of iron it would be impracticable to build sea-going ships. The rapidity of the motion of the *Agamemnon,* when she had the cable on board, had the effect of nearly disintegrating the ship, and she must have had an enormous strain upon her when she suffered in the way that had been already publicly described. The principle advocated by Mr. Rennie could only, he was afraid, be used in exceptional cases. Mr. Scott Russell said, the French Government were carrying on a series of experiments, as were also the English Government; but although he had been informed of the nature of these experiments, he was not at liberty then to communicate them. The English Government were adopting a very wise and judicious course—they were making their experiments now before they built their ships. The point with which, as mechanical men, they had to do, was whether wooden vessels of war were equal to the work of iron vessels. If the English Government found that war ships would be more advantageously constructed with shot-proof sides, and otherwise protected with iron, then he had no doubt that engineers and ship-builders would be found who would both get the material and construct the vessel in a proper manner. And he was also of opinion that it was possible to make ships with shot-proof sides, which would have also good weatherly qualities. After some further discussion, the Chairman, in summing up, said that the Admiralty, some fifteen years ago, had decided against iron ships in consequence of the experiments they then made.

To this discussion may be added the following:

Mr. Anderson, of the Royal Arsenal, Woolwich, at a late meeting of the Society of Arts, said an immense effort had been made to manufacture wrought-iron plates of great thickness, for the purpose of floating batteries, so as to render them shot and shell proof; but, although plates had been turned out eight or nine inches thick, yet they failed to afford effectual resistance to these missiles. He thought they might look with some hope to the metal introduced by Mr. Howell as affording a valuable material for ordnance; or to some combination of pure iron with carbon, so as to get a material that could be cast in a mass suitable for cannon. Mr. Anderson expressed a high opinion of the value of Mr. Howell's homogeneous metal, for machinery that was intended for exportation to long distances, and where a large amount of wear and tear was expected. This, he said, had been exemplified in the case of some boilers sent to Russia.

The failure of 9-inch plates to resist solid wrought-iron shot can

hardly be doubted, but we think Mr. Anderson is in error when he pronounces them not *shell*-proof. There is a wide difference between the power to resist wrought shot and the power to resist cast shells, and, while the thick plates may well be expected to fail in respect to the former, we do not doubt their efficacy in respect to the latter. This distinction should be carefully borne in mind by those who have to contrive shell-proof ships. The plates employed should not be too thick to prevent solid shot passing clean through them.—*Mechanics' Magazine*, No. 1814.

IRON BRIDGES.

PROF. RANKINE has stated to the Institution of Engineers in Scotland:

The construction of Iron Bridges of great size still continues to be one of the leading features of the engineering of the time. The forms of bridge which have been practically tested may be divided into five classes—the arch, the suspension-bridge, the tubular girder, the lattice girder, and the bowstring girder; of each of which I shall cite one recent example:—The arch exemplified by Mr. Page's Westminster-bridge, which has the broadest roadway in the world; the suspension-bridge, by the bridge of the same engineer at Chelsea; the tubular girder, by Mr. Stephenson's enormous viaduct across the St. Lawrence, at Montreal; the lattice girder, exemplified in the form invented by Captain Warren, by the Crumlin viaduct, which, constructed by Messrs. Liddell and Gordon as engineers, and Mr. Kennard as contractor, crosses the vale of the Taff at the height of two hundred and twenty feet; and the bowstring-girder, exemplified in a novel and singular form, and on a gigantic scale, by Mr. Brunel's viaduct at Saltash, in which the string of the bow, which in the original form of the bowstring-girder was a straight tie, is made to take a curved or rather a polygonal form, and to act as a suspension chain. The great works which I have cited as recent examples of viaducts are interesting in other respects besides the superstructure. The piers of the Crumlin viaduct, which I understand to have been designed by Mr. Kennard, consist of a skeleton framework of iron, being excellently adapted to the purpose of attaining an immense height at a moderate expense. The bases of the piers of the new Westminster-bridge may be briefly described as consisting mainly of cast-iron boxes filled with concrete. Those of the Victoria bridge at Montreal are of massive granite masonry, remarkable for the cost which has been incurred in order to enable the piers to withstand the floating ice of the river. The central pier of the Saltash viaduct is founded by a process originally practised at the new Rochester bridge, but never before carried out on so great a scale, consisting in the sinking of vertical iron cylinders filled with compressed air, inside of which the excavators and masons work. The completion of those great structures will furnish important data for settling the question as to the most economic mode of crossing *wide valleys at great heights*, and of founding heavy structures under *difficulties of various kinds*. A sixth class of bridge, which I men-

tion apart because it has not yet been practically tested, its probable success having been inferred from theoretical calculations verified by experiments on a reduced scale, is the suspension bridge, adapted to the passage of railway trains by a stiffening framework of strength sufficient to prevent the undulations which would otherwise endanger the structure. This is the design of Mr. P. W. Barlow's bridge at Londonderry, which, should it answer its purpose of safely carrying trains at considerable speed, will probably be found the cheapest mode of crossing spans which lie between certain limits.

SUSPENDED CANALS.

A VERY happy adaptation of the suspension bridge is its use to carry canals. When used for that purpose, the suspension bridge requires no stiffening framework, and is subject to no undulations, except such as may be caused by the wind; for, as each boat displaces its own weight of water, the load is always uniformly distributed. This invention of Mr. Roebling has been employed with success in America, but has not yet been introduced into Britain. It is probable that it might be found an easy and cheap method of carrying aqueducts for the supply of towns, or of water-mills, across deep valleys.—*Prof. Rankine.*

LIGHTHOUSE FOR RUSSIA.

AN Iron Lighthouse has been constructed by Messrs. H. and M. D. Grissell, at the Regent's Canal Iron-works, Hoxton, to be erected upon the island of Seskar, in the Gulf of Finland, about forty miles this side of Cronstadt.

The tower is circular, and is constructed of cast-iron plates, 100 in number, each plate being 10 feet in height and 10 in circumference. The base of the tower is 20 feet in diameter, the top under the gallery is 12 feet, the height of the whole being 82 feet. Around the top, on the outside of the column, is a gallery which projects three feet. The plates which form this column vary in thickness from 1¼ to ¾ of an inch, and have strong internal flanges, which are made perfectly level and reduced to one uniform size under the planing machine. These plates are secured together by upwards of 2000 bolts and nuts. In the centre of the tower is a large pipe, eighteen inches in diameter, extending from the bottom to the top, and which serves to assist in supporting the various iron floors by which the compartments are divided. This pipe also carries the dioptric light, and the weight which causes that portion of the light to revolve, and whereby the flashes are produced.

There are five wrought-iron floors carried upon wrought-iron beams, and supported by the internal flanges of the plates, and the centre column before alluded to. These floors are reached from stage to stage by a neat wrought-iron semi-spiral staircase. The different rooms or compartments are lighted by small plate-glass windows, which are provided with a very simple but clever contrivance for keeping them shut or partially open to any angle, and so securely as to resist the force of the heaviest gale of wind.

On the summit of the column is placed the lantern, which is a 12-sided figure, having a base of cast-iron plates, and surmounted with solid gun-metal sash-bars, framing thirty-six large panes of plate glass of half an inch in thickness. This is again surmounted by a galvanized wrought-iron framed roof, and covered with the patent fibrous slab, impervious to the influence of excessive heat and cold, as well as fire-proof and indestructible. On the top of this slab covering is another covering of copper, and beneath a galvanized wrough-iron ceiling. Upon the apex is mounted a cowl, a large hollow ball of copper open at the bottom, and into which passes the ventilating chimney of the light. On the outer periphery of one side, and directly under the feather of the arrow vane, are pierced many small square

holes, always sheltered from the wind, by which it follows that the wind in passing causes at the back of the ball a partial vacuum, into which the heated air from the lantern and light instantly passes, thereby keeping the light room proportionately cool, and allowing of no downdraught, and thus preventing that flickering of the light which is so frequently seen in badly ventilated light rooms.

The tower and the lantern are painted a bright red, which is allowed to be the best distinguishing colour for hazy and foggy weather. The internal portion of the lantern in the daytime is hung with strong linen curtains to exclude the rays of the sun. These are found to be indispensable, inasmuch as the power of the sun's rays falling upon the foci of the lenses of the rotatory portion of the light is so great that the brass of the lamp would be melted without such a shade.

The light is constructed according to the dioptric system of Fresnel, and was manufactured purposely for Messrs. Grissell, by Messrs. Chance, Birmingham. By this system one single lamp placed in the focus of the apparatus suffices to throw a brilliant sheet of light in every direction of the horizon. This particular light belongs to the second order or size of dioptric light, and is termed a revolving light with flashes. The middle belt consists of twelve lenses, each of which comprises a series of concentric refracting rings, so as to have the effect of transmitting all the rays of light which fall upon it from the burner in a pencil of parallel rays; so that the revolution of this belt of lenses will cause the appearance of a succession of flashes, the rate of this succession being a means for enabling the mariner to distinguish any particular revolving light. Whatever rays therefore from the lamp fall either above or below this system of lenses are intercepted by a series of horizontal circular prisms, of which thirteen are placed above and five below the lenses, each of them being so formed as to reflect internally all the light which enters it, and to cause all the emerging rays to be parallel to each other, and to those which are transmitted by the lenses. This portion of the apparatus is technically designated the "catadioptric" part, from its combining reflection with refraction in intercepting and transmitting the light, whereby there is always a steady uniform light visible from this catadioptric portion even during the interval of darkness of the lenticular belt. The lamp which is used within the apparatus has a constant flow of oil saturating and overflowing from its three concentric wicks by means of beautifully constructed internal pumps, which are moved by clockwork. There is also a clever addition, whereby the ceasing of the overflow and supply of oil puts in action an alarum to attract the notice of the attendant. The self-acting rotatory machinery by which the lenses are made to revolve at the required rate is an ingenious piece of clockwork, which performs its duty most correctly.—*Times*, May 1, 1858.

CANAL TUNNEL.

A TUNNEL made under the Rowley Hills, 1¾ mile long, has been opened in connexion with the Birmingham Canal. The width is 27 feet, of which 17 feet are water way, and the height is 16 feet above the water, and the depth of water 6 feet. The tunnel was begun September 28th, 1855, and took nearly three years for its completion. Boats can pass each other, as the channel is wide enough, and the whole distance can be performed in forty-five minutes, which formerly used to occupy eight hours. There is a towing path on either side of the water, and the interior of the tunnel is lighted with gas. The cost has been 300,000*l*.

THE ENGLISH LIGHTHOUSE SYSTEM.

MR. A. G. FINDLAY has communicated to the Society of Arts a paper "On the Progress of the English Lighthouse System." At the present time, when parliamentary enactments are about to be introduced for the regulation of steamers' lights, and other collateral topics, *this is a subject of* some importance. Mr. Findlay demonstrated *that it is to William* Hutchinson, harbour-master of Liver-

pool, that we are indebted for the invention of the "reflector," or English system of illumination; he having introduced it into the Liverpool lighthouses in the year 1763. The credit of the invention has been given by the usual authorities to the French, who did not use it till twenty years later. After describing the systems in use in 1847, the period of a former communication by the author, the holophotal system of Mr. Robert Stevenson was described, and illustrated by some beautiful apparatus. It is considered that our lighthouses are very nearly the perfection of the means employed. But, while this system is so excellent, a fresh sort of confusion and danger is growing up in the improvement of the lights carried by steamers, which, as shown by the examples exhibited, rival in brilliancy those of the floating-light vessels. The vast increase of collisions is particularly attributed to this. The electric light, or rather magneto-light, of Professor Holmes,—then nearly ready for exhibition in one of our lighthouses,—is believed to be a great addition to the perfection of our system. The future direction for further improvement is considered to be the proposition of Mr. George Herbert, for mooring floating-light vessels outside the "dangers," and for forming a line of such floating lighthouses, to be illuminated by the electric light, up our principal channels;—all steamers and vessels in one direction to pass on one side, and those in the opposite direction, on the other; thus relieving these crowded highways of much embarrassment, and adding greatly to the security of navigation.

THE NORTH FORELAND LIGHTHOUSE LANTERN.

A NEW Lantern has been constructed for this Lighthouse. It is 14 feet wide, and 22 feet from the floor to the apex of the roof. It is sixteen-sided, with diagonal astragals. By this direction of the astragals, the interception of light is confined to a small oblique space; were they upright, they would at certain points intercept the light throughout the whole height of the refracting belt. Moreover, the greater stiffness and strength which this arrangement gives to the framework of the lantern make it safe to use more slender bars, and thus, also, absolutely less light is intercepted. The panes of glass at the same time become triangular, and are stronger than rectangular panes of equal size. The lantern is formed for the most part of gun-metal and copper, so as to render painting unnecessary. The St. Gobain glass is used, in the belief that it is very much better than English glass. If it be so, our manufacturers should look to it, and learn the reason why. The cost of the lantern is from 1300*l.* to 1400*l.*; the cost of the light apparatus about 1000*l.*—*Builder.*

SIGNAL LIGHTS AT SEA.

PROFESSOR G. WILSON has read to the British Association a communication "On a Danger attending the Use of Red and Green Signal Lights at Sea." This is a most valuable practical paper; it commences by stating the Admiralty regulations, that "1. All *sea-going vessels*, when under way, or being towed, shall, between *sunset and sunrise*, exhibit a *green light* on the starboard side, and a

red light on the port side of the vessel. 2. The coloured lights shall be fixed wherever it is practicable, so as to exhibit them, and shall be fitted with in-board screens projecting at least three feet forward from the light, so as to prevent the lights being seen across the bow." The author then went on to show that these regulations, which would effectually secure the object intended in most cases, would be most dangerous should a seaman be put to steer or look out who had that peculiar kind of blindness of which he had encountered many instances, of not being able to distinguish red light from green. The statistics of the colour-blind is defective, not including females ; but there is reason to think that not less than 1 in 20 is defective in this respect, and of the markedly colour-blind not less than 1 in 50 males is so. Out of 1154 persons, including students, soldiers, and policemen, examined by the author, 1 in 55 was markedly colour-blind,—*i. e.*, entirely unable to distinguish the colours red, brown, green, and blue. The author suggests two remedies :—1. A change of the system itself, which in its details must be left to nautical men. 2. An examination of all masters, mates, and pilots in the merchant service as to their power of distinguishing coloured lights within the limits of vision, and rigorously excluding those who could not, and excluding from the Royal Navy all above the rank of sailors who are colour-blind.

IMPROVED BREAKWATERS.

THERE has been communicated to the Institution of Civil Engineers, "A Description of a Breakwater at the Port of Blyth, and of certain Improvements in Breakwaters, applicable to Harbours of Refuge," by Mr. M. Scott, M. Inst. C.E. The communication was divided into four parts—the first referring particularly to the breakwater at the Port of Blyth ; the second to the theory of waves ; the third to the theory of hydraulic construction, including form and methods of building ; and the fourth relating exclusively to the author's designs, including his assumed improvements in the construction of breakwaters, which had been suggested by his experience in connexion with the work at Blyth. In reference to the questions of durability and cost, the author was of opinion that properly-prepared timber would last twenty years, and that the section for a depth of ten fathoms would cost completed about 70*l.* per lineal foot ; whereas the stone breakwater at Alderney was said to have cost 190*l.* per foot, and that at Portland 150*l.* per foot. This difference in first cost was so great as to leave, it was considered, an ample margin for the renewal of the timber when it decayed.

THE PATENT BOOM DERRICK.

"A MONSTER Floating Derrick" has been launched from the Thames Iron Works and Ship Building Company, at Orchard-yard, Blackwall. The name bestowed by the American inventor on this remarkable structure is "The Patent Boom Derrick ;" and it is thus minutely described in the *Illustrated Times*, No. 184 :—

The "scow," or vessel on which the Derrick is placed, and into which its standards are built, is of a rhomboidal form amidships, for a length of about 95 feet, tapering off, both toward stem and stern, in the shape of two slightly waved-line edges; so that she is built sharp fore and aft, and carries a rudder at each end. The length over all of the vessel is 257 feet, and her breadth amidships, up to where the tapering-off lines begin, is 90 feet on deck, and 81½ feet at the bottom, which is perfectly flat.

This enormous pontoon or hull, which is twelve feet wider than the *Great Eastern*, is divided throughout her length by an elliptical truss or girder, weighing nearly seventy tons, having a span which approximates to that of the centre arch of Southwark Bridge, and a height of 30 feet. Two smaller arch trusses are placed diagonally across the hull, intersecting the main arch through its centre, and through each other almost at the same point. The internal capacity of the hull is again subdivided into upwards of eighty cells, each about 14 feet square. There is a twofold object in this arrangement: first, to strengthen the general construction of the hull; and secondly, to form water-tight compartments throughout *one* of its sides, for the purpose of admitting water-ballast, to serve when raising a vessel as a counterpoise to the *other*, into which the Derrick proper, or lifting machine, is built.

In an ordinary crane or Derrick, the "jib" or "boom" which sustains the weight projects wholly from one side of a standard or support, and requires countervailing weight or resistance to prevent the supports being dragged away by the weight which is being raised; but in the Patent Derrick the boom is extended and affixed to both sides of the standard, or "king post," which rests on the upper part of a huge hollow cone formed of standards, placed at the requisite points, and firmly secured together by cross-beams and diagonal ties. On the top of this structure is placed a massive bearing with a concave groove corresponding to the circumference of the "king post," which, having both back and front booms affixed to it, and being shod with an inverted or convex groove, rests upon the bearing just mentioned, and is enabled to revolve freely upon a number of steel balls placed between the two grooves by what is known as ball and socket action. The end of the "boom" opposite to that employed in lifting is connected by several travelling "brace-rods" of great strength, with the base of a circular framework of iron; and the end of these rods being provided with friction-wheels, admits of the weight being moved within the range of a circle, the radius of which is one-half the length of the "boom."

When required to be put into use for raising a sunken ship, the lifting-boom projects over that side of the "scow" or vessel upon which it is erected, and is provided with ten sets of purchase-blocks, each of which possesses a hoisting power of 100 tons. A chain passes over each of these blocks, and is led down the inside of the hollow "king post," which is 7 feet in diameter, at the height of nearly 100 feet above the deck, and thence to one of a series of ten powerful "crabs," which are placed on the side of the deck opposite to that of the hoisting boom. An aggregate power of 1000 tons is thus made available upon a sunken ship or other object. In raising a sunken vessel, water is admitted into those compartments of the "scow" which are on the side opposite to that on which the hoisting takes place, thus providing a counterbalance to the accumulating dead weight. From its peculiar construction, the "scow" has a very light draught of water, not exceeding 30 inches. When launched, it was necessary to pump 300 tons of water into the hull to keep it sufficiently steady under the weight of its top-gearing; but in raising a vessel, the accumulation of strain will, as such vessel approaches to the surface of the water, force the hull down many feet. Within the hold are placed two steam-engines for propelling the vessel, and two others for working the Derrick's gear for raising the ships. The huge machine is moved by means of a revolving chain passing over two wheels placed on each side, and provided with moveable floats. This chain and its floats revolve in a sort of channel or sewer, nearly 90 feet in length, protected by the outer iron plates of the vessel's side, and which dip below the surface of the water. The Floating Derrick carries no sails.

It is on the basis of the enormous "scow," or hull, that the Derrick proper, or hoisting apparatus, is fixed. It comprises five triangular-shaped iron legs, formed of inch-and-a-quarter plates of iron, which support, at a height of 50 feet, the enormous hoisting "boom." This boom is 120 feet in length, and its broadest part 30 feet in breadth. It is formed of thick plates of iron riveted together, and

which, seen from below, appears as though one of the Thames steamers had been taken up bodily and placed on the towering hollow cone structure. Through a hole in its centre (this forming the pivot upon which the boom turns) is the great "king post," in the interior of which a game of whist might be conveniently played. The height of the post above the "boom" is 50 feet, and it is surmounted at the top by a huge iron cap weighing 25 tons, to which are attached the chains supporting both ends of the "boom." The total height from the deck to the top of the "king post" is 130 feet. The following are the particulars of the power, dimensions, and weight of the various parts of this extraordinary machine:—The power is—hoisting capacity above the surface of the water, 1000 tons; gear for working, 10 sets of crabs, independent of each other, worked by two oscillating engines of 30 nominal horse-power each; propelling power, two pair of oscillating engines of 160 horse-power each pair, all fitted with Barran's patent cup-surface boilers. The weight of the scow or hull (without Derrick) is 750 tons; of the Derrick, including legs, boom, "king post," casting, and rods, 250 tons; making a total weight of scow and Derrick, with propelling or hoisting machinery, about 1200 tons. The dimensions are—length over all, 257 feet; breadth, 90; depth, 14; height from deck to boom, 80; ditto of "king-post" above boom, 50; radius of boom, 60. This machine is capable of depositing its load anywhere within a circle whose diameter is 120 feet. The measurement of the vessel is 5000 tons, and the entire cost about £40,000.

NEW BRIDGE, CHELSEA.

This new Bridge, connecting Chelsea and Battersea, has been completed, and opened to the public.

The bridge has been designed by Mr. Page, and is on the suspension principle. At the site chosen, the Thames is 737 feet in width. The river is spanned by three spaces, the central being 352 feet between the piers, and the side ones 173 feet 6 inches each; the two piers in the river are 19 feet wide each by a length of 86 feet 6 inches. The height of the caissons of the piers, above Trinity high-water level, is 7 feet 6 inches. Above the level of the top of the caissons the piers are surmounted by towers, constructed principally of iron. They diminish in plan to 9 feet 8 inches by 4 feet 2 inches at top, the whole being surrounded by a cradlework of cast iron, upon which the rollers of the saddles work that carry the suspensory chains. Below the caissons the ironwork spreads out at the bottom on "bed-plates," that rest upon York stone landings, below which are piles and concrete supports. Externally the whole of the piers are covered with an ornamental casing of iron-work. The point of contact of the suspensory chains on the towers is at an altitude of 51 feet 8 inches above high-water mark; and the top of the finials, that terminate the towers, is 88 feet 6 inches from the same level. The abutments of the bridge, both on the Chelsea and Battersea sides of the river, have each "a relieving arch" in the centre, which serves the purpose of distributing the weight uniformly, the space between the arch and abutment being filled with concrete. The abutments, as well as the piers, rest firmly upon piles, which have been driven 20 feet beyond low water mark. There are also piles driven at an angle in front of the mooring chamber, as an extra security. The roadway and overhanging footways of the bridge are embedded in asphalte on a ground or foundation of cork and bitumen asphalte. On each side of the carriage-way is placed a tram for the heavy traffic. A very large amount of additional strength is ob-

tained over the ordinary mode of construction that has hitherto been adopted in the formation of suspension-bridges, by the introduction of two longitudinal lattice girders of wrought iron, one of which is inserted on each side, and separate the roadway from the foot-paths. At each end of the bridge are picturesque lodges, octangular in plan, the roofs covered with Portland cement, and their angles and summits adorned with appropriate terminations in terra-cotta. The four towers that rise over the caissons and piers in the river are highly picturesque in form, and are entirely constructed of iron, except 18 feet of their upper portions at top, which are of moulded copper, which is gilded and painted to resemble light-coloured bronze. The summits of the towers are crowned with globular lamps. The towers bear the royal arms, with the monogram "V. A." Yet, this public way across the Thames has a horse and carriage and foot toll; although the Bridge was ostensibly constructed in order to afford the inhabitants of Middlesex access to Battersea Park, on the opposite bank of the Thames! This anomaly of paying toll for crossing a Government bridge to obtain admission to a free public park was loudly urged in Parliament, and the people themselves held a great public meeting prior to the opening of the Bridge, which, however, for want of proper organization, defeated rather than aided the cause. For more than twenty years past has been agitated the removal of tolls from certain of the metropolitan bridges; yet here is an additional bridge *with a toll*, and that a Government structure, leading to a free, public park. Thus, while we are clamouring for parks and playgrounds for the people, a toll is levied upon their walk to one of these places of recreation. The affair of the Chelsea Bridge was an administrative bungle of an outgoing and incoming minister; which, however, might have been prevented, had Members of Parliament attended to their local duties, and not left the matter to chance, and the poor and mean compromise of the foot toll being free upon certain public holidays.

NEW WESTMINSTER BRIDGE.

THE completion of this new Bridge is not calculated upon until the close of the year 1859, owing, it is stated, to the delay of the Board of Works in entering into the contracts for the iron work. The new bridge will occupy all the site of the old one, and as much more ground in addition. In order to avoid the expense of a temporary bridge during the erection of the new one, it has been determined by Mr. Page, the engineer, to build half the new structure at a time—that is, half its width. The piers for the western half are (Sept., 1858) complete, but all those for the eastern half cannot be commenced till the old bridge, which occupies the ground, is quite removed. Wherever the eastern halves of the piers pass under the archway of the present bridge they are being continued as speedily as practicable. Only four, however, can be thus proceeded with—the old piers being in the way of the remaining three. But by even thus carrying the four piers through at the present time, Mr. Page is effecting a considerable saving of time and money, as the new piers

not only strengthen the old structure, but will eventually serve as centres from which to take it down.

At the date of this Report, (Sept. 1858,) the workmen were carrying through, under the centre arch of the old bridge, the eastern half of the piers for the new. These piers, being nearly 100 feet long by 17 feet wide, of solid masonry, of course, by consolidating the ground, prevented further sinking of the old piers. No sinking, however, had taken place for some time ; in fact, if any further settlement did occur, the whole mass would come down like a cardhouse. How it has ever held up for so long a time in its present state seems perfectly marvellous. When the western half of the piers of the new bridge had to be sunk alongside the piers of the old, the latter of course were partly cut away to make room, a rather dangerous operation at the time. The section thus exposed showed that the piers between the arches had never been built in regular courses of masonry, but that they were merely hollow walls, filled up inside with coarse rubble. When one of the new piers we have mentioned was taken under the centre arch of the present bridge, it was necessary to alter and remove the centering of timber which apparently supported the ruinous arch. It was then found that these supports (which, at their best, were only the poorest and weakest kind of pinewood) were so rotten that had the bridge really been settling, they would no more have withstood any pressure than so many trusses of straw.

VICTORIA-BRIDGE, CANADA.

ALTHOUGH the Britannia Bridge represented the most scientific distribution of material which could be devised at the date of its construction, it has since been improved upon by the same engineer in the Victoria-bridge, now in the course of construction across the river St. Lawrence, near Montreal. The Victoria-bridge is, without exception, the greatest work of the kind in the world. For gigantic proportions and vast length and strength there is nothing to compare with it in ancient or modern times. The entire bridge, with its approaches, is only about 60 yards short of two miles. It is five times longer than the Britannia-bridge across the Menai Straits, seven-and-a-half times longer than Waterloo-bridge, and more than 10 times longer than the new Chelsea-bridge across the Thames! The Victoria has not less than 24 spans of 242 feet each, and one great central span—itself an immense bridge—of 330 feet. The road is carried within iron tubes 60 feet above the level of the St. Lawrence, which runs beneath at a speed of about 10 miles an hour, and in winter brings down the ice of some 2000 miles of lakes and upper rivers, with their numerous tributaries. The weight of iron in the tubes will be upwards of 10,000 tons, supported on massive stone piers, each of solid masonry. So gigantic a work, involving so heavy an expenditure, has not been projected without sufficient cause. The Grand Trunk Railway of Canada—one of the greatest national enterprises ever entered on—is upwards of 1100 miles in length, opening up a vast extent of fertile territory for the purposes

of future immigration, and, by connecting the settled provinces of Western Canada with the seaboard States of the American Union, calculated to afford full scope for the development of the industrial resources of that magnificent colony. Without the Victoria-bridge the system of communication would have been manifestly incomplete; the extensive series of Canadian railways on the north side of the St. Lawrence, terminating opposite Montreal, would, for all purposes of through traffic, be virtually sealed up during the six months of the year that the St. Lawrence is closed against navigation by the ice, and the Grand Trunk system must necessarily have remained to a great extent nugatory, in consequence of the province being cut off from the coast, to which the commerce of Canada naturally tends.—*Quarterly Review.* This stupendous Bridge is described in the *Year-Book of Facts*, 1858, p. 18.

GRAND TRUNK RAILWAY OF CANADA.

MESSRS. PETO, BRASSEY, AND BETTS, the contractors for the Victoria-bridge at Montreal, belonging to this Company, have progressed during the past summer at a rate that gives hope they may be able to open it for traffic in October, 1859, instead of on the 1st of January, 1860, in accordance with the terms of their last contract. It is estimated that if these two or three months can be gained, they will probably make a difference in the receipts of the Company for the second half-year of 1859 of from 70,000*l.* to 80,000*l.* The number of hands at the work on 1st October, 1858, was 3281, apportioned as follows:—Fitters and smiths, 153; riveters and platers, 121; carpenters, 280; masons and stonecutters, 326; painters, 19; labourers, 1331; raftsmen, 49; boys, 75; crews of steamers and barges, 450; men employed at the Canada works, Birkenhead, in the construction of tubes, 477. There were also employed on the bridge 142 horses. The bridge consists of twenty-four spans of 242 feet each, and one in the centre of the river of 330 feet. The spans are approached on each side of the river by a causeway, each terminating in an abutment of solid masonry 240 feet long and 90 feet wide. The causeway from the north bank is 1400 feet long, that from the south bank is 700 feet.

THE SUBALPINE TUNNEL.

AN interesting communication on this important subject has been received by the French Academy of Sciences from M. Menabrea, one of the most distinguished members of the Piedmontese Parliament. It was stated several months ago that the immense work of boring a Tunnel under the Alps between Modane and Bardonèche had commenced; but we have now to record some noteworthy facts which might, perhaps, never have been discovered but for the peculiar methods employed in this colossal operation. Modane and Bardonèche are situated on opposite sides of the Alpine chain which divides Piedmont from France, and precisely at a point where the

valleys of the Arc and the Dora, which lie nearly on the same level, run parallel to each other, and the mountain is narrowest. The thickness of the intervening mountain is thirteen kilometres in a straight line; the actual tunnel will be twelve and a half kilometres. It is designed in the same vertical plane, but, to facilitate drainage, is somewhat higher in the middle than at the orifices, so as to form gentle slopes on both sides—one not exceeding an inclination of five per thousand, and the other being twenty-three per thousand, in consequence of a difference of level between the two extremities, the numbers being,—Bardonèche (southern orifice), 1324 metres; culminating point, 1335 metres; Modane (northern orifice), 1190 metres above the level of the sea. The crest of the mountain being 1600 metres higher than the culminating point, the sinking of shafts, which is the method generally employed in order to begin boring tunnels at several points at once, was out of the question; hence the tunnel could only be worked at its extremities, so that the labour by the ordinary processes could not be accomplished in less than thirty-six years. Then, how was a depth of gallery of three or four kilometres, and having but one orifice, to be aired? These were all serious obstacles. MM. Elie de Beaumont and Angelo Sismonda having examined the mountain geologically, found it to contain micaceous sandstone, micaceous schists, quartzite, gypsum, and limestone, all easy to blast, the quartzite alone excepted; but the stratum of this is not likely to be very thick; the other difficulties alone therefore remained, and these were at length overcome by three Sardinian engineers, MM. Sommeiller, Grattone, and Grandis, who proposed to turn the abundance of water for which the locality was remarkable to account by applying it to a peculiar system of perforation and ventilation, which we will now endeavour to explain.

The first apparatus devised by these gentlemen consists in an hydraulic air-condenser, which is a syphon turned with its orifices upwards, and communicating by one of them with a stream of water, by the other with a reservoir of air. The water, descending into the first branch, enters the second, and by the pressure it exercises condenses the air, which is then forced into the reservoir. This done, a valve is opened, by which the water contained in the syphon is let out, and the operation recommences. The emission and introduction valves are regulated by a small machine operating by means of a column of water; and the air in the reservoir is maintained at a constant degree of pressure by a column of water communicating with another reservoir above. Thus, with a waterfall twenty metres in height, the air is condensed to six atmospheres, equivalent to the pressure of sixty-two metres of water. This condensed air is used for two purposes—first, as a motive power, and then for ventilation. Two kinds of perforators, worked by condensed air instead of steam, are employed, one invented by Mr. Bartlett, the other by M. Sommeiller; and the manner in which these machines perform their duty affords the first practical demonstration of the possibility of employing compressed air as a motive power with advantage. By means of these perforators, holes for blasting may be bored through the

hardest sienite in one-twelfth of the time which would be required if ordinary means were employed.

In order to understand the importance of this result, it may be stated that, in tunnelling, three-fourths of the time is employed in boring holes, and the remainder in charging and blasting; hence, accelerating the former operation is an immense advantage. The perforators have another advantage; in a place where three couples of miners would hardly find room, eighteen perforators may be set to work; so that, by these ingenious contrivances, as well as by others for clearing away the rubbish, the perforation of the tunnel may be effected in six years, instead of thirty-six. The air that has been employed as a motive power is used to feed the gallery; but when the latter shall have reached a considerable depth it will require 85,924 cubic metres of air per twenty-four hours to replace that which has been vitiated by respiration, torches, and gunpowder; and this quantity, in the form of 14,320 cubic metres of air condensed to six atmospheres, the reservoir can furnish. A new and curious fact has been observed during these works—viz., that when the air condensed to the degree above-mentioned is shot into the gallery from the machine, any water happening to be near the latter suddenly congeals, although the ambient temperature be about 18° Centigrade (72° Fahrenheit). Hence, when a large mass of compressed air is driven into a gallery situated at 1600 metres below the outer surface of the earth, and where consequently the temperature must be about 160° Fahrenheit, the dilatation of the compressed air produces a diminution of temperature sufficient to counterbalance the excess alluded to. The progress now making per day in boring is three metres on each side of the mountain, or six metres per day in all.—*Times*, July 8, 1858.

BRITISH RAILWAYS.

At the present moment we learn, from returns recently published, that we have in this country alone 9500 miles of Railway executed and in actual operation; and taking, at a rough calculation, one locomotive engine with a force of 200-horse power to every three miles of railway, and assuming each to run 120 miles a day, we thence calculate the distance travelled over by railway trains to be equal to 380,000 miles per diem, or the enormous distance of 138 millions of miles per annum, a space measuring the distance of the planets, and beyond the conception of those unacquainted with figures. To transport engines and trains this distance requires a force equivalent to that of upwards of 200,000 horses in constant operation throughout the year.

As regards the commercial value of Railways, suffice it to observe that a clear revenue of twelve millions is left, after all expenses are paid, for distribution amongst shareholders and creditors. This amounts to three and three-quarters per cent. per annum—a small return upon 320 millions, the original cost of 9500 miles of railway, on an average of 34,000*l.* per mile.—*Mr. Fairbairn*; *Proc. British Association, 1858.*

RAILWAYS IN FRANCE, ENGLAND, AND IRELAND.

THE Inaugural Address of the President of the Institution of Civil Engineers (Mr. Joseph Locke, M.P.,) related to the principles and character of the French Railway System, which the President was encouraged to attempt in consequence of the late President, Mr. Robert Stephenson, having so fully discussed the main features of English Railways—the origin, progress, and results of which are in many respects strikingly dissimilar to those of the Continent.

Our limits will only allow the quotation of a few of the leading points of Mr. Locke's valuable paper.

The practical results in England have been immense convenience and advantage to the public who use, and inadequate profit to those who have constructed, our railways. But in France the terms are reversed, the capital invested yielding a good profit, whilst the service to the public, although far in advance of all former means of conveyance, is still very limited.

In contrasting the systems, it was shown that the real difference is greater than is apparent on a mere comparison of per centage of income and profit; and that other things being equal, the advantage may be assumed to be in favour of England, in all that is essential to the success of improved communication; and all circumstances being considered, the result should have been a higher rate of profit from railways in England than in France.

The essential characteristics of the French system are—first, the determination by the State of the locality and direction of the main arterial lines of railway; and secondly, the process which the State, whilst adhering to its general rule, of absolute control over the selection of lines, has thought proper to employ, in order to obtain the desired progress in their construction.

The total cost of the 7030 miles conceded is estimated at about 24,600*l*. per mile: 19,600*l*. is to be provided by the Companies, and 5000*l*. by the State; what the actual cost would ultimately be is not yet ascertainable.

A comparison of the expense of construction of the French and English railways exhibits an unfavourable picture of the latter; the estimated cost of the former being about 24,688*l*. per mile, whilst that of the latter is about 31,690*l*. per mile.

The cost of railways will probably be diminished in future in England, whilst in France they have not yet reached the culminating point, as between the years 1841 and 1854 the cost gradually increased from 18,600*l*. per mile to 26,664*l*. per mile.

In return for its aid and protection from rivalry, the French Government has secured the gratuitous conveyance of the mails, and has laid a tax of 10 per cent. on passengers, and on first-class goods, which two items yield 5 per cent. on the sum of 36,000,000 of subventions. Low tariffs are fixed for soldiers, sailors, prisoners, paupers, &c.—participation, in some cases, after certain division of profits—and the possession, as the end of the concessions, of all the railways in France. After all these considerations, the French system appears to have reconciled the interests both of the promoters

and of the State, as whilst the former have obtained a liberal return for their outlay, the latter have secured substantial benefits, for the aid they have given; in short, the railway interest in France has not, as in England, been made a victim of public exigencies and private cupidity.

Yet the limited service for the public on the French lines, as compared with the English system, is deficient. This induces economy, and influences the profits; still, the cost of fuel, and all that belongs to the locomotive power, is greater than in England.

French railways are almost entirely imitations of those already completed in England, where the experiments were made, and where both the engineers and the operatives had to acquire their experience practically.

Several instances were given by Mr. Locke, of his own personal experience in the construction and maintenance of French railways. He found it, at the beginning, indispensable to secure the co-operation of experienced contractors, and this induced the introduction by Messrs. Brassey and Mackenzie of the machinery and skilled labour at their command, in order eventually to instruct others in similar works. The success which attended their efforts, particularly those of Mr. Brassey, not only in France, but in nearly every part of the globe, fully justified the importation of Englishmen to France for the intended purposes.

One of the most striking consequences was the introduction of the class of "navvies," whose appearance, habits, manners, and mode of work, were equally novel to the French; yet they soon became perfectly at home, and inspired such confidence among the native labourers, that they would not undertake any task-work unless the gang was headed by a "navvie." The force of the example of these men is now manifest, in the improved style of work on the French lines, so that there is now little, if any, difference in the relative values of the labour obtained from each. Thus, the introduction of English labour, far from being a grievance, as was assumed, as previously in the case of the iron trade and machinery manufacture, considerably improved the condition of the French working class.

Large manufactories of engines have been created, equal to the supply of the wants of the country, and English mechanics are now scarcely seen on any other than the Rouen Railway. Neither the precision of manufacture nor of manipulation have, however, yet reached the English standard; nor has the economy of working been brought so low, notwithstanding the speed being lower, the wages being less, and the trains less frequent, better filled, and carrying less dead weight.

In absolute construction there is little to remark. The masonry is more lavish in quantity; the slopes of cuttings are not flat enough, and are frequently pitched with stone; the rails are chiefly the double-headed parallel, as first used on the Grand Junction line, in England; the gauge is identical with the English standard, and uniform throughout the country; and the permanent way generally differs but little from the majority of the British lines.

One national peculiarity is the employment of females in the booking-offices, level crossings, &c., and other departments of French railways, to the duties of which they are found well adapted.

In summing up, it was observed that the difference in estimated cost per mile of the lines hitherto conceded, or made in France, as compared with those in England, might be taken at 5000*l.* to 7000*l.* To this must be added in the French promoter's favour the 5000*l.* per mile furnished by the State. If, however, from the English rate were taken the outlay solely due to disadvantages from which the French were exempted, the difference in favour of the latter, making every allowance for the more even surface of their country, would be consideraby reduced.

IRISH RAILWAYS.

MR. G. W. HEMANS has read to the Institution of Civil Engineers a paper "On the Railway System in Ireland, the Government Aid afforded, and the Nature and Results of County Guarantees." It appears that, in 1854, the French railway shareholder received, on an average, 9 per cent.; while, on the other hand, in 1857, the English railway shareholder only obtained 3·12 per cent., or less than what was derived from money invested in the public funds. In the one case, assistance and protection have been afforded by the Government; but in the latter, as is well known, speculation has been allowed to take its freest development. The result is that, at the end of 1856, in England and Wales alone, with an area of 58,000 square miles, there were 6441 miles of railway opened; but in France, with an area of 204,000 square miles, there were only 4060 miles of railway opened; so that England and Wales were relatively 500 per cent. better furnished with railways than France, and at the same time the accommodation on the individual lines was superior. It might be assumed, however, that although the shareholders lost by competing lines and duplicate stations, the country gained; for in no case has any line been actually closed for want of traffic, or because it is valueless. In conclusion, Mr. Hemans states:—"At the end of 1856, there had been constructed, in Ireland, 1056 miles of railway, rather more than one-half of which were single line, though the works were for double way. The cost had amounted to fourteen millions, the average per mile having been less than 15,000*l.*; but lately this had been reduced to from 6000*l.* to 7000*l.* per mile. The average receipts were 21*l.* per mile per week, the dividend amounted to 4¼ per cent. nearly, and the working expenses to 39 per cent. In England these figures were—receipts 60*l.* per mile per week, dividend 3·56, and working expenses 49 per cent. respectively; the cost per mile having reached 40,000*l.* The favourable result here indicated is attributed to economy in construction and in working."

SUBSTITUTION OF COAL FOR COKE IN RAILWAY LOCOMOTIVES.

A *CORRESPONDENT of the Times*, writing from Arbroath, *September 20, 1858, says:—*

It is perfectly apparent that if Coal can be substituted for Coke in the working of Locomotive Engines, an immense saving to railway companies will ensue, both from the reduced expenditure for fuel and the increased duration of the boiler tubes, &c. That such substitution may be made without annoyance to the public from smoke has been proved during eighteen months in the working of a smoke-preventing appliance in use on the railway between Aberdeen and Perth. This appliance is very nearly, if not altogether, the same in every detail as that used by Mr. Lees, of the East Lancashire Railway. The result proves that the smoke arising from the use of coal in locomotives may be entirely prevented by the adoption of a firebox, and by the judicious introduction of a quantity of cold air to mix with the gas generated during the progress of the coal towards perfect incandescence.

A patent for the smoke-prevention appliance was secured by Mr. Yarrow, locomotive superintendent of the Scottish North-Eastern Railway, running from Aberdeen to Perth; his main object being the invention of a cheap and simple apparatus which might be applied to engines at present in use. This patent bears date the 18th of March, 1857, as may be seen by a reference to the *Engineer*, of date the 6th of November, 1857, page 337.

Since that time Mr. Yarrow has attached his patented improvements to most of the locomotives under his charge on the above railway, making use of the brick arch. In one of the engines, however, the arch or midfeather was constructed of copper with a water space, and this engine has been (September 20) running with it ever since. The water space arch has also been introduced into the fireboxes of two new engines erected in the workshops at Arbroath.

Mr. Yarrow has also altered the furnaces of several stationary engines in this quarter, and with complete success as to the prevention of smoke. At least in this and the neighbouring manufacturing towns there is no doubt of his patent being adopted generally by the proprietors of public works, to avoid the infringement of the Act of Parliament lately come into force in Scotland.

WORKING ON RAILWAY INCLINES.

A PAPER has been read to the Institution of Civil Engineers, "On the Successful Working, by Locomotive Power, over Gradients of 1 in 17, and Curves of 300 feet radius, on Inclines in America," by Mr. T. S. Isaac.

It was stated, that the road which had decidedly taken the lead in the United States, in the application of locomotive power to steep gradients, and had been generally the pioneer of improvements, was that extending from Baltimore, on the Chesapeake Bay, to Wheeling, on the Ohio River, a distance of three hundred and eighty miles, through a region of considerable difficulties, especially in the various ranges of the Alleghany Mountains. This company was *incorporated in 1827*, and a portion of the road was opened in May, *1830, but it was not* until 1851, or three years previous to the opening

of the Sömmering incline, that the great incline over the main range of the Alleghanies was completed, and worked by locomotives. This latter had an inclination of 1 in 45¼ for eleven continuous miles; and, after winding amongst the summits of the mountains for twenty miles, it descended on the western side, with an inclination of 1 in 45¼ for nine continuous miles. The passage of this mountain-chain involved altogether sixty miles of railway, twenty miles of which had a gradient of 1 in 45½, and nine miles of 1 in 50, both worked by locomotive power, at a speed of from fifteen to twenty miles per hour for passenger trains, and from ten to fifteen miles per hour for goods trains.

Steep gradients and sharp curves had since been adopted on the Virginia Central Railroad, on a more extended scale, and had been in successful operation for upwards of four years. The Mountain Top incline on this road crossed the Blue Ridge Mountains, at Rock Fish Gap, in Virginia. It was four miles and one-third long, with a ruling gradient of 1 in 18·87.

RAILWAY-CARRIAGE ROOF LAMPS.

Mr. C. Defries, (of the well-known firm of Defries and Sons, Houndsditch,) has exhibited and explained to the Institution of Civil Engineers, some specimens of his Improved Railway-Carriage Roof Lamps. Three objects are sought to be accomplished in these lamps. First, by admitting cold air into the burner, thus preventing the oil from boiling, the overflowing of the oil in the glass, so common in other lamps, is prevented. Secondly, a simple method of fixing the glass is adopted, so that by having a stock of glasses at different stations, a broken one might easily be replaced; instead of, as at present, it being necessary to send the damaged lamp to the repairing shops, in order that a new glass might be soldered in. Thus, a much smaller stock of lamps will be required, and less expense will be incurred for repairs; in addition to which the chance of breakage, in the transit from the stores, will be entirely removed. Thirdly, the interior of each lamp is made in one piece, instead of three or four pieces, as customary. This tends to increase the light, which is remarkably clear and brilliant.

NOVEL RAILWAY SIGNALLING APPARATUS.

M. Aimont, of Paris, has patented in the United Kingdom, the construction of an Indicating Apparatus, as follows:—Upon a disc of card or other suitable material are marked, around the circumference thereof, a number of points representing the relative positions of all the stations, crossings, curves, and other places with the positions of which it is desirable that the driver shall be acquainted, these points all being spaced off according to their distances apart, from a starting point which represents the terminus from which the train is to start. The disc thus marked has a central aperture, behind which a watch, clock, or chronometer is placed, so that the face of it may be visible through the aperture, and near the edge of

the disc a fixed needle or pointer is placed. Behind the said needle or pointer the card is made to rotate by means of gearing driven by the axle of the locomotive, the gearing being so proportioned and adjusted that while the locomotive travels from one station to another, the point on the disc which represents the former station shall move from the needle, and that which represents the latter station shall arrive at it. An engine-driver provided with such an apparatus by inspecting the disc will observe the exact position of his train upon the line; by inspecting the time-piece will observe the time; and by comparing the two will observe the speed at which he is travelling. The apparatus being entirely independent of external influences, will not be liable to error or failure from fog, darkness, or other like causes.—*Mechanics' Magazine*, No. 1841.

WHITWORTH'S RAILWAY SIGNALS.

MR. C. F. WHITWORTH has illustrated his recent improvements in Railway Signals by two very pretty models. One of those represents a line of rails in the neighbourhood of a station with the distant signal. By slightly inclining a particular pair of rails, and fixing a communication between them and the signals, the train announces itself as soon as it passes over the permanent way, and the signal, exhibited for the information of succeeding engine-drivers, announces that a train has just passed, and that it would be dangerous for them to continue their journey until the obstruction is removed. Mr. Whitworth has also exhibited a model of a railway signal intended to be attended by an ordinary signal man. The new principle in it is the use of a wheel instead of a lever. This wheel, like the wheel of a vessel, moves the arms of the signal, and registers the fact of its having done so, by ringing a bell both at the station and at the wheel itself. In misty weather, consequently, the signal man will be perfectly aware when he had discharged his duty and when the proper signal was displayed.

SAFETY RAILWAY INDICATOR.

M. REGNAULT, one of the chief functionaries of the French Western Railway, has invented an Indicator for announcing the departure of trains at the different stations along a line. The apparatus consists in a dial-plate, with a hand which may move right or left, according to the direction in which the train is to start. The station-master at the terminus from which the departure takes place, has only to press with his finger on a knob with which the dial-plate is provided, to make all the apparatuses of the same kind along the line mark the departure; the hands remain in the same situation even when the communication is interrupted, and (this is the most important point), should an inattentive station-master press on the knob of his indicator while the hand marks the impending arrival of a train, the hand will not obey this wrong impulse, but remain where it is, and thus call the station-master's attention to the mistake he was about to commit.—Paris Correspondent of the Times.

APPARATUS FOR WORKING RAILWAY BREAKS.

A MODEL has been exhibited to the Institution of Civil Engineers, by Mr. Hall, of an apparatus by which railway carriages are coupled together, so as to make the action of the breaks continuous throughout the train, and thus render it possible to apply three or four breaks simultaneously. A longitudinal square bar is suspended under each carriage, the connexion being made by a universal joint coupling. In making up a train, the great blocks of the great vans are screwed up close to the rims of the wheels, and then the coupling is effected, so as to avoid the possibility of slack. The break-blocks are so arranged on the carriages that two operate in each direction, so that the carriages may be moved either backwards or forwards, indiscriminately; but this is not the case with those attached to the tenders and the break-van. The mode of applying the power is similar to that ordinarily in use. There is a worm-wheel on the spindle of the handle from the van, working into a cog-wheel, fast on the longitudinal shaft. On this shaft there is also a screw working in a loose collar, to which is attached the ends of one pair of levers, operating the arm of a lever, on a fixed shaft, also carrying the levers to which the blocks are attached.

O'NEILL'S IRON TELEGRAPH FOR RAILWAY TRAINS.

A MODEL of Mr. O'Neill's Iron Telegraph for Railway Trains has been exhibited to the Institution of Civil Engineers.

An iron bar, extending under each carriage, is suspended on a pin a little from the centre, so as to make one end heavier than the other. The heavy end is securely held in a bridle, by a hanging latch; whilst the light end, which also passes through a bridle, has a tongue which draws out from the bar, and reaches under the latch fixed on the next carriage. By disengaging any one of the latches the heavy end falls, and the light end, in rising, throws up the next latch, and so on to the guard's van, where the last light end is arranged so as to ring an alarm. A chain, or wire, can be fixed to each latch and brought into the carriage, so as to give the passengers, in the event of danger, the means of signalling to the guard. A duplicate set of bars on the other side of the carriage enables the guard instantly to communicate with the driver, if necessary. The end of each tongue has a rising point rivetted loose, so that the porter, when coupling the carriages, can put it in position for disengaging the latch, in case the carriages should become detached by the breaking of the coupling chains. As the bars are not connected, any number of carriages can be taken off, or put on, at a station, by merely turning the loose point on the end of the tongue up or down. The cost of applying this apparatus, it was estimated, would be about thirty shillings per carriage.—*Mechanics' Magazine*, No. 1814.

WALKING ON WATER.

M. OCHSNER, of Rotterdam, is said to have invented a mode of Walking on Water, and he has been called "the first podoscapher." The "podoscaps" are a species of sabot, about fifteen feet long and

nine inches high (or deep). Standing erect, the podoscapher, provided with a pole flattened at the end (for paddling), and twelve feet long, can advance, turn, or recede with great swiftness in water not deeper than the length of the pole. M. Ochsner won a wager by ascending the Rhine, from Rotterdam to Cologne, in his podoscaphs in seven days. The novelty of such a mode of progression on water, however, is not so unprecedented as appears to be imagined. About thirty-five years since, the writer witnessed a decidedly less clumsy and more ingenious mode of walking, treading, or riding on water, in the harbour of Leith. This consisted of a machine not unlike a velocipede, but mounted on water-tight floats instead of wheels. The inventor, mounted on this machine, with hinged paddles on his feet, made rapid progress over the surface of the water. The floats, in the present instance, are superseded by the "sabots;" but while these latter are no less than fifteen feet long, the former were little more than as many inches in length and depth: there were three of them, one before and two behind, and the apparatus floated by them was of slight iron rods, on which a saddle was fixed which the water-treader bestrode.—*Builder.*

TO MAKE PAPER IMPERVIOUS TO WATER.

THE following preparation for Waterproofing Paper intended for packages exposed to the weather is said to be recommended by Professor Muschamp, of Wurtemberg. Take 24 oz. of alum and 4 oz. of white soap, and dissolve them in 2 lb. of water: into another vessel dissolve 2 oz. of gum arabic, and 6 oz. of glue in the same quantity of water as the former, and add the two solutions together, which is now to be kept warm, and the paper intended to be made waterproof dipped into it, passed between rollers, and dried; or, without the use of rollers, the paper may be suspended until it is perfectly dripped, and then dried. The alum, soap, glue, and gum form a kind of artificial leather, which protects the surface of the paper from the action of water, and also renders it somewhat fireproof. Merely to convert paper into artificial leather, this would be rather a complicated process compared with the dipping of the paper in diluted oil of vitriol, and then washing it immediately with water and drying; but the Professor's method may perhaps render paper more impervious to water.

COMBUSTIBLES MADE FIREPROOF.

IT was long since suggested in the *Builder*, that the dresses, curtains, and other combustible properties in theatres, might easily be rendered incombustible. "A wonderful discovery" is described in the French papers, which appears to be a fresh realization of this suggestion. A Mons. Carteron is the inventor, it is said, of a new kind of "paint," which renders everything to which it is applied perfectly fireproof. In presence of the Emperor and Empress, a series of experiments to test the value of this invention has been made. Fire was applied to some ladies' dresses, but without any effect, thus proving that articles of the lightest texture may be rendered non-

ıtible. An attempt was afterwards made to set fire, by means hes, to the tent of a superior officer, completely fitted up with curtains to the bed, &c., but without effect. A hut built of ınd thatched with straw, was operated on; but the half to the new invention had been applied remained uninjured. A heatre, with all the scenery, &c., prepared with the composi- ›sisted every attempt to set fire to it.

WATSON'S PATENT VENTILATORS.

T of the ships of the Royal Navy, recently fitted for sea in our rds, have been furnished with a number of Ventilating Appa- ı, the invention of Mr. Charles Watson, of Halifax. They plicable to buildings of every description, and are of very construction. A single tube or flue is employed for the pur- livided throughout into two passages or shafts, one for the ding fresh air, and the other for the ascending vitiated air; vided tube generally passing through the roof of the building, rming a direct communication from the ceiling of the apart- o be ventilated to the external atmosphere. It can, however, pted to almost any situation, and has been applied to build- f many floors or flats, and to the lower and middle stories of ıctories, where the heat and steam are withdrawn by a modi- n of the same arrangement, without taking the ventilating tube h the floors above to get through the roof, the tube being through the side wall and terminating outside at the required -*Mechanics' Magazine*, No. 1809.

PREVENTING DOWN DRAUGHTS IN CHIMNEYS.

. H. WETHERELL, of Upper Chapman-street, St. George's East, ıtented a singular but very efficient apparatus for the above ıe. It consists of a valve and valve-seat made and acting as ter described. He fits a seat in metal or other suitable al at any desired height in a chimney or flue, and above the ıspends a ball filled with some gas lighter than atmospheric he ball offers no impediment to the passage upwards of smoke, d air, or any other ascending current; but any descending t is effectually stopped by the valve, which is thereby forced on to its seat.—*Mechanics' Magazine*, No. 1815.

ROOF OF THE LEEDS NEW TOWN HALL.

. C. BRODRICK, in a paper read to the British Association, es of this novel construction:—

ırincipal points which are worthy of notice in this roof are the absence of ns, which allows of the ceiling of the hall being brought nearer to the · of the roof than is usually the case. The roof consists of eight sets of ıls framed together. Each principal consists of a semicircular laminated ned of twelve 1½-inch planks, 9 inches wide, nailed together and fastened ·ought iron bolts and straps. They are placed in couples, and stand im- ıly over each of the columns in the Hall. They are respectively 4 feet and apart. The width of the room is 71 feet, and the springing of the ribs rom the ground. The entire height to the top of the roof is 90 feet, the ng 78 feet high in the clear. This system of roofs has been adopted more-

frequently in France than in England, the only one with which he was acquainted of any considerable size being the station of the Great Northern Railway, at King's Cross. The laminated rib is the invention of a French engineer. It was at first suggested for a bridge over the Rhine, in the year 1811. Several years later, M. Emy constructed several roofs on this plan; but all his roofs, as well as the one at King's Cross, being very near to the ground at their springing, and without ceilings, are consequently much more manageable than the roof of the Town Hall, which has a very elaborate plaster ceiling attached to it, and the springing is at a considerable distance from the ground, he had taken the precaution to insert several additional struts and braces as a preventive against any change of form or outward thrust. Both these points had been attended with the most complete success, there being not the least perceptible outward thrust or change of form since they were put up. The latter fact was proved very satisfactorily by the plasterers, who were enabled to run the mouldings on the ceiling from the centre. The brackets for these mouldings were not gauged from a centre, but fastened to the ribs according to their sizes. In constructing these semicircular ribs, he was much struck with the small amount of springing or alteration of form. If the principle of these laminative ribs were better understood, he was of opinion that many of our church-building architects would adopt it instead of depending on three or four over-strained joints for one tie.

Mr. Scott Russell said the roof of the Town Hall appeared to open to us the English era of circular architecture. He hoped that the example of the Leeds people in selecting a good architect and a good plan, and letting the good architect carry out his own plan in his own way, would be generally followed in the country. As strangers, all the members of the Association must congratulate the architect on having employed the best principles known in our time, and at a moderate expense.

CHUBB'S NEW TILL.

THE frequent plundering of shop-tills of late has induced Mr. Chubb, the scientific lockmaker of St. Paul's Churchyard, to invent one of a new description, made of iron, and so encased as to ensure perfect security as regards all attempts to obtain access to the contents by any other means than the legitimate key. Such a thing as pilfering from this Till, by any sly side-wind, like those to which too many tills are liable, is here out of the question. Nothing short of unscrewing it from the counter, and walking off with it bodily, would serve the purposes of dishonesty in this case; and perhaps Mr. Chubb will excuse the liberty we take in suggesting to him, that an additional security, in the prevention even of such a contingency, might easily be obtained by bolting and riveting its fastenings through the counter, instead of merely screwing it on to the under side. The article is so massive and weighty, that there must be a constant pull upon ordinary screws, hanging it up in this way, at any rate; so that a double advantage would thus be gained.—*Builder.*

PLANE-STOCKS MADE BY MACHINERY.

PLANE Irons are very largely made in Sheffield, but it has been necessary to send them to London, Birmingham, &c., to be fitted with stocks, which have been made by hand. Messrs. Brooks and Sons, of the Howard Works, Sheffield, have purchased an extensive set of machinery, to manufacture them with greater rapidity, accuracy, and cheapness, than can be attained by hand labour. The

ries of machines consists of eight, arranged in one large room. he first machine cuts the blocks out of the plank. The second, by he action of two circular cutters, planes their sides. The third takes ff the ends of the blocks. Then comes a curious machine for sinking he mortise. Two chisels, from opposite directions, work to and rom a point in succession. The bed on which the block rests gra-nally rises, bringing it within reach of the chisels, which, by suc-essive strokes, cut out the mortise to the required depth. The fth is the mouth-cutting machine. Another circular-cutter, of still maller diameter, cuts a groove with two semicircular ends for the oat. Then comes the abutment machine. The wedge is cut by a eparate machine. The next is the bedding machine, which makes lso the breast cut and the cut for the ware.

DIGGING MACHINE.

THIS machine, the invention of Mr. Ricketts, is a locomotive ngine, with flue-and-tube boiler, propelling itself slowly by means of inions, spur-wheels, and cog-teeth on the inside of one of the broad-ellied travelling wheels; and, at the same time, driving, with pitch-hains from pinions on each end of the engine crank-shaft, a revolving igger hung transversely behind. This digger consists of a strong haft of 2¼ inches square, and about seven feet long, on which are ided a number of curved arms, carrying prongs or spade-shaped utters or shares of chilled cast-iron. The circle described by the cutters 2 feet in diameter, and the digger rotates in the opposite direction that of the carriage-wheels, so that the blades enter the hard ground rom below, carry over the loosened soil, and deposit the pieces mostly an inverted position. The digger makes, say, about sixty revolu-ions per minute, while the engine advances 45 feet in the same me; and, as there are two cutters in one ring (at opposite iameters), each cutter takes 4½ inches "bite." Three men are equired to work the machine. Going 5 inches, and sometimes inches or 8 inches deep, it makes very fair work, according to the *Mark-lane Express*—good enough to show that on light land in dry reather it might be a valuable tool.

EFFECTS PRODUCED ON GLASS BY EXPOSURE TO WATER.

AT the recent meeting of the British Association, Dr. C. W. Bingley ead a paper "On the Effects produced on Glass by Exposure to the ction of Mud in Water." Along with several other articles lately ound in the lake at Walton Hall, near Wakefield, were a piece of rindow-glass and the remains of an ancient bottle. It is supposed hat they have been buried in the mud ever since the Hall was ttacked by Oliver Cromwell's soldiers. The interest these specimens ossessed, in a scientific point of view, consisted in the remarkable ppearance they presented after their submersion, possessing hues of olour rivalling those of the finest specimen of pearl shells. The nud in which they had been embedded contained a large quantity of rganic matter and sulphide of hydrogen. On scraping the glass rith a penknife, the coloured part was easily detached in minute

scales, those exhibiting the red or deep orange rays of colour coming off easily, when green or bluish scales became disclosed to view, which were with more difficulty removed. The glass underneath appeared as if it had been ground, or subjected to the action of hydrofluoric acid. The scales consisted of silicates of lime with iron, but with no potash or soda. The glass consisted of a silicate of potash and soda, with a very slight trace of iron and lime. The glass appeared originally to have been a pure alkaline silicate. The potash originally in it seemed to have been replaced by lime and iron derived from the water, in the case of the detached scales. It has been known for a long time that water acts more or less on glass, slowly decomposing it into a soluble alkaline silicate. Scheele observed that water which had been boiled a long time in glass vessels became alkaline. Ebelman published, some time ago, an account of the strong action of water charged with carbonic acid on glass. That ammonia assists the action of moisture or water very materially may frequently be evidenced in the case of stable windows. It is possible that, in the present case, the silica of the glass after the separation of the alkali may have been left in a gelatinous state, as a condition necessary for its subsequent combination with lime and iron, derivable from the water, to form the less soluble silicate of which it is constituted. The glass, viewed by transmitted light, exhibited rays of colour complementary to the reflected rays.

TOMB OF THE DUKE OF WELLINGTON, IN ST. PAUL'S CATHEDRAL.

AFTER a lapse of nearly six years from the date of the death of the illustrious Wellington, his remains have been placed in a sarcophagus of porphyry in a chamber of the crypt of St. Paul's Cathedral. This sarcophagus was wrought and polished by steam power in the parish of Luxulyan, in Cornwall, in the field in which the boulder stone of porphyry, weighing upwards of 70 tons, nearly the whole of it above the surface of the ground, had been standing for ages. The Continent had been searched in vain for a sepulchral stone sufficiently grand for a sarcophagus that should contain the mortal remains of the great Duke. That stone was at last found in Cornwall, and the whole of the work was executed by workmen in the employ of the Treffry estate, whose representatives were entrusted with the work throughout. The cost of the tomb was 1100*l.*

HYDROBORONATED PLASTER.

THE Patent Hydroboronated Plaster consists of common plaster of Paris (or "any plaster having sulphate of lime for its base"), indurated by a solution of boron. This solution can, of course, be made of varied strength, and so the cement may be made to set in any period, *i.e.*, in a few hours or moments, according to the work to be bestowed upon it.

The effect of the hydroboron is to render the plaster very hard, and fit it for the imitation of marbles and stones. Its actual

strength is considerable, and the patentee believes he could construct a column of it capable of bearing an equal pressure with freestone. The process ensures the evaporation of the liquid; hence the surface is fit for paint almost immediately. It possesses every advantage claimed on behalf of other cements, with two additional qualities—viz., its setting being retarded according to wish, and, in point of price, being considerably cheaper.

It is in the imitation of marbles and stones that the patentees have principally used it, and the result of their experience is satisfactory. We confine ourselves, as in other cases, to pointing out a new material for trial.—*Builder.*

ARTIFICIAL STONE.

A NEW combination of mineral substances for the production of Artificial Stone has been provisionally specified by Mr. F. Puls, of Haverstock-hill. The invention has reference to the production of artificial stone for ornamental and other purposes, and consists in the combination of powdered emery, flint glass, ruby, diamond, melted alumina, oxide of iron, or similar hard mineral substances, with proportionate quantities of lime, barytes, plaster of Paris or chalk, and silicate of potash or soda, or potash and soda powdered in solution, or in a semi-fluid state. For the production of stone for lithographic or ornamental purposes, Mr. Puls combines lime or chalk powder with silicate of potash or soda, or otherwise, to which colouring matter may be added as required; and for meerschaum mixes carbonate of magnesia or oxide of magnesia, or a mixture of both, with silicate of potash, soda, or otherwise, to which may be added small proportions of slaked lime, chalk, or clay. Either of the above compositions may be pressed into moulds, warm or cold, to give it the required shape, and render it close and compact.—*Builder.*

HYDRAULIC CEMENTS.

A PAPER on this subject has been submitted to the Paris Academy of Sciences by M. F. Kuhlmann, showing the advantage to be derived from the combination of silicates with mortars and cements in general, and especially with those that are intended to resist the action of sea-water. It is well known that the first effect of water on cements is that of forming hydrates; after which a gradual contraction takes place, producing a degree of hardness, which increases in proportion as the contraction is slower, and there is more silex or alumina in the cement. Now, M. Kuhlmann has observed that if alumina or its silicate, or else magnesia, whether caustic or carbonated, be kneaded into a paste with a solution of silicate of potash or soda, the compounds resulting therefrom will bear a perfect resemblance to the natural silicates, such as feldspar, talcous slate, magnesite, &c., and will, by repose and slow contraction, become hard and semi-transparent, resisting in a high degree the corrosive effects of water. *If slaked lime be added to the said compounds, they acquire the properties of hydraulic cements.* M. Vicat, jun., having

shown that calcined magnesia added to a cement would resist the action of sulphate of magnesia, M. Kuhlmann has endeavoured to turn this observation to account, by mixing calcined dolomites (which contain magnesia) with mortar, with the addition of alkaline silicates. This composition he finds very advantageous, since most of the salts contained in sea water must contribute towards the preservation of such cements. In fact, the chloride of magnesium, as well as the sulphate of magnesia, will be decomposed and form a layer of silicate of magnesia on the surface of the cement; in the same manner, the sulphate of lime must, being in contact with the silicate of potash or soda, form a silicate of lime; and all these silicates strongly resist the action of sea-water. As for sea-salt, which is a chloride of sodium, M. Kuhlmann proves that, in the proportion in which it exists in sea-water, it will slowly decompose the silicate of potash contained in the cement and leave the silex free. The compositions proposed have therefore the singular property, not only of resisting the corrosive qualities of sea-water, but of actually becoming more insoluble the longer they are in contact with it. A cement composed of 30 parts of rich lime, 50 of sand, 15 of uncalcined clay, and 5 of powdered silicate of potash, is recommended by M. Kuhlmann as having all the requisite hydraulic properties, especially for cisterns intended for spring water. In marine constructions, care should be taken to add an excess of silicate to those portions of cement which are exposed to the immediate contact of the sea.—*Galignani's Messenger.*

HYDRAULIC MORTAR.

THERE has been read to the Institution of Civil Engineers, "An Investigation into the Theory and Practice of Hydraulic Mortar, as made on the New Works of the London Dock Company, 1856-57," by Mr. G. Robertson, Assoc. Inst. C.E. The theoretical points treated of in the paper were those connected with the calcination and slaking of blue lias lime, the action of silica in protecting it from solubility, the setting of mortar, and its subsequent absorption of carbonic acid. The second, or practical part, gave a detailed account of the method and cost of manufacturing mortar at the London Docks; as well as the effect of grinding on its strength and density.

MACHINERY FOR THE MANUFACTURE OF BISCUITS.

MR. W. G. SLIGHT, C.E., Edinburgh, has communicated to the Scottish Society of Arts, a paper illustrating the mechanical appliances now in use in some of the best and most extensive Biscuit manufactories in this country and abroad for the production of ship and other biscuits cut out of sheets of dough. The simplest form of machine, as used for ordinary shop trades, consists of a pair of rollers mounted in a metal frame, and worked by hand, by which the dough, previously mixed and kneaded, is worked and rolled out to a sheet of uniform thickness, after which it is cut out into biscuits by simple hand cutters. An advance in the application of hand machinery is

where a machine is employed for cutting, of one of the kinds mentioned below, after the dough is rolled out by the first machine. A complete set of machinery to work by power consists of different machines for the various operations of mixing, kneading or braking, cutting, and in some cases baking, or passing the biscuits through the oven. Mixing is performed either by a set of knives or rakes revolving within a close cylindrical vessel, or by a revolving flat pan, in which a heavy metal roller rests and turns, working and squeezing the ingredients into a mass of dough. Braking is usually performed by a single pair of rollers, fitted with a reversing motion, between which the dough is passed backwards and forwards until sufficiently worked. Of cutting machines there are two forms employed, the most expeditious being the cylinder machine, so called from its having the cutters mounted on the surface of a roller or cylinder. This cylindrical cutter revolves in contact with a plain metal roller, and as the dough passes between them it is cut into biscuits, which are delivered in front of the machine, either on boards or on tins ready for being placed in the oven, while the waste or scrap is carried away behind. In the other arrangement of cutting machine, the dough rests on an endless web after being rolled out to the proper thickness, and passed underneath a set of cutters working up and down; the web and dough stand during the cut, and move forward the breadth of the biscuit on the rising of the cutter. The most perfect form of this machine has a web for removing the scrap after the dough is cut, and the biscuits are slidden off the main web to a tin moving forward at the same rate on a third web underneath. The application of machinery to baking is in the moving of the biscuits slowly through a long oven; they, being put on an endless chain of plates or web of wire-cloth, passing right through the oven, are delivered baked at the other end.

THE ARITHMOMETER.

MR. W. E. NEWTON has patented an improved machine for performing the addition of numbers, quantities, or sums of money, to be termed the Arithmometer.

This machine is composed of a system of indicating wheels numbered on their peripheries, and geared together, and a system of keys representing the numerals arranged to be operated by the fingers to produce the movements of the indicating wheels. The most important features of the invention consist in the means employed to combine the keys with the indicating wheels to produce the movements of the latter; also the means of controlling the movements of the keys so that neither of them may produce any greater movement of the indicating wheels than is required by the numeral it represents; also in providing for the shifting of the indicating apparatus relatively to its driving gear, so that the motion may be imparted from the said gear to the units wheel, or wheel representing the smallest *quantities or values, or to either* of the wheels representing greater *quantities or values.* And further, in a certain improvement in the

gearing of the indicating wheels to impart the necessary movement from the index-wheel of any denomination to that of a higher denomination.

IMPROVEMENTS IN DYEING.

MR. CRACE CALVERT has read to the Society of Arts, a paper "On recent Scientific Discoveries as applied to Arts and Manufactures," in which he noticed a great variety of valuable applications to the arts of substances hitherto comparatively valueless, or which had been used for different purposes. The discoveries that have been made by Mr. Perkins, Mr. Lauth, Mr. Saac, by himself, and some foreign chemists, in the production of colours from coal-tar, guano, and from grass, formed the most remarkable of those described. From coal-tar there have been extracted beautiful purple and pink dyes, which are rendered permanent on cotton, silk, and woollen manufactures by special mordants, and specimens were shown of some beautiful prints from the works of Mr. E. Potter, of Manchester, the colours of which were extracted from coal-tar. By a very recent invention, these colours can be permanently fixed on mixed fabrics, such as mousseline de laine, which it is expected will prove of great advantage in the manufacture of that article, and give English goods of that kind the lead in the markets of the continent. All the colours that have been obtained from madder, Mr. Calvert said may be extracted from coal-tar, with the important advantages of cheapness and of retaining their colour. Valuable discoveries have been made also in the production of Turkey red, which facilitates and cheapens the making of that dye. Dyers are dependent on the supply of Gallipoli oil, of a peculiar kind, for steeping the cloths to be dyed red; but the property which that oil possesses is found by chemical analysis to depend on the fatty acid in the oil, and that property can now be communicated to several common oils with great certainty of effect. The dressing of fustian goods has been greatly improved by an application by Mr. Calvert and his assistants of one of the ingredients in coal-tar. The bone size with which it has been customary to dress those goods is apt to putrefy, and as it is sometimes applied to the amount of sixteen ounces to a yard, the smell becomes extremely offensive, and the fabric itself is mildewed and seriously injured. The extract from coal-tar produced by Mr. Calvert has the same effect in dressing the fustian, and it is free from those objections. There were specimens of the two articles on the table, and the one dressed in the ordinary method gave strong evidence of being in a putrescent state. The improvements in the manufacture of British gum from potato-starch, which is used extensively in printworks, have succeeded in depriving it of colour, in rendering it free from acidity, more soluble, and more effective.

SCIENTIFIC INQUIRIES AS TO GUTTA PERCHA.

THE Council of the Society of Arts have appointed a Committee to direct the institution of a series of experiments on Gutta Percha, and

the causes of its decay, its different qualities, adulterations, and other points of interest or importance in regard to this most useful substance. To these ends, a series of queries are to be issued by the committee for circulation amongst those most likely to be able to afford the desired information. We would suggest that one of the series of experiments projected ought to have for its object the *artificial production* of gutta percha, by chemical conversion of such plentiful substances as bitumen or asphalte, resins, pitch, and albuminous substances, &c. Chemists, as we have more than once pointed out, know well that in certain experiments with bitumen, a substance has been produced bearing a strong analogy to India-rubber; and, when it is considered that now the very perfumes of the finest flowers can be perfectly simulated, or, in fact, artificially and actually produced, out of such "villanous smells" as that of coal-tar, and even of something worse, one cannot see why both gutta percha and India-rubber may not be artificially produced from cheaper and more abundant materials, by the protean transformations of organic chemistry. Let us not be misunderstood: we do not mean merely that some inferior or trashy substitute may be found or manufactured from a mixture of other materials, but that to all intents and purposes the very substances themselves may be artificially produced, by chemical transformation of other organic materials—and that bitumen, for example, is essentially organic, just as pitch is known to be, there cannot be a reasonable doubt; but whether it be so or not, it is a most promising material for such a purpose as that suggested.—*Builder*, No. 795.

MANUFACTURE OF SAFE MATCHES.

MR. H. HOCHSTAETTER has patented certain improvements in the manufacture of Matches which contain no poisonous matter, and are not injurious to the workmen: they are made by dipping the ends in an igniting composition made by combining chloride of potash, chromate of potash, binoxide of lead, red sulphate of antimony, or sulphur of antimony, or any other metallic sulphur, gum, or starch, pumice-stone or manganese, flower of sulphur, or milk of sulphur. The addition of chlorite of lead causes the matches to ignite more readily.

NEW METHOD OF ROAD-MAKING.

THE everlasting noise which is occasioned by the rugged material of our English roads, and the frequency of their being under repair, gives especial value to a fact which we find in the French journals. A new system of Road-making has just been substituted for the ordinary roadway on a part of the Place du Palais Royal. A quantity of concrete, about 5 in. in thickness, is first spread out, and on that is applied a layer of bitumen reduced to powder and in a boiling state. On this latter, which is also about 5 in. in thickness, a quantity of river sand is sifted, and then the surface is pressed down by a heavy *cast-iron roller*, weighing about two tons. In a few *hours after, the road thus* made may be passed over by the heaviest

waggons without the slightest impression being left by the wheels. The same system has been applied to that part of the Rue St. Honoré comprised between the Palais Royal and the Rue de Richelieu, and in the latter street as far as the end of the Théâtre Français.

OAK PAPERS.

Mr. John Stather, of Hull, has produced Oak or "wainscot" Papers. The grain, being printed from a piece of the wood itself, and thus being perfectly true to nature, far surpasses any produced from blocks engraved by hand. From the same piece of wood, the pattern can be varied almost *ad infinitum*, for by simply taking off a shaving a different design appears.

WOOD EMBOSSING.

A newly invented process for so softening Wood that it may be pressed into iron moulds, and receive permanent and sharp impressions in bas-relief, has, under the name of Xyloplasty, attracted much notice in Paris. The wood is softened by steam, and imbued with certain ingredients which impart to it sufficient ductility to enable it to receive bas-relief impressions from four to five millimetres in height. —*Mechanics' Magazine*, No. 1834.

LOFTY CHIMNEYS.

The large Chimney-stalk in connexion with the works of Messrs. Charles Tennant and Co. has for the last eighteen years—viz., since its erection in 1841—enjoyed the proud reputation of being the highest in the world, or 450 feet. On the canal-bank, at a short distance to the westward of the said works, and on the same elevation, a new stalk is being built at the works of Mr. Townsend, manufacturing chemist, Crawford-street, Port Dundas, and its projected height is 460 feet.

Messrs. Crossley, of Halifax, have completed a new chimney in connexion with their works at Dean Clough, which, although placed in a valley, has attained a level with the summit of Beacon-hill. Its height is 127 yards (381 feet), the width at the bottom being 10 yards. The weight of brick and stone used in the erection is estimated at 9685 tons.

EXPLOSION OF GUNPOWDER BY IMPACT.

Captain Norton writes to the *Mechanics' Magazine*, No. 1840, as follows:—"In the *United Service Magazine* for October, 1858, p. 277, is the following passage:—'There is no instance known of common gunpowder being kindled by a blow from a hammer on an anvil, or an analogous manner.' About four or five years ago, when in Dublin, the idea was floating in my mind that gunpowder might be ignited by being placed on an anvil and struck with a heavy hammer. In order to test it, and set the matter at rest, I went to Mr. Kennan's machine factory, in Fishamble-street, and requested him to allow one of his men to make the experiment; he kindly and promptly did so, placing himself about half a drachm of

sporting powder, which he took from a flask of his own, on the anvil. His man struck the powder first with a light hammer, the blow from which did not ignite the powder; he then placed the like quantity on the anvil, and the man struck it with a heavy hammer, when it exploded; this was repeated three or four times without failure. I reported this fact in some of the papers at the time, and lately, when I read the above passage in the *United Service Magazine*, I was determined to reassure myself of the truth of what I had asserted publicly, and went to the Bandon terminus here and requested Mr. Barber, the sub-engineer, to try the experiment. I placed, as before, half a drachm of sporting powder—it was Hall's rifle powder—on the anvil; Mr. Barber struck it himself with a heavy hammer, when it exploded with a sharp report. I mention these facts, because the idea that gunpowder cannot be ignited by such means, or accidental means similar to it, being promulgated and prestiged through the columns of the *United Service Magazine*, might lead to the most disastrous consequences, such as the blowing-up of artificial firework storehouses."

NEW PORTCULLIS.

SOME experiments have been made by the troops belonging to the Royal Engineers, for testing the strength of the Portcullis Chain Barrier recently invented by Captain S. Westmacott, R.E. The experiments came off at Fort Amherst, near the Belvidere Battery, where one of the portcullis barriers had been again erected. Since the last experiments were undertaken, some improvements have been effected by Captain Westmacott in the invention, with the view of giving increased strength to the chain barrier, as it was found on the occasion of the former experiments that the portcullis was destroyed in a part where it was considered the strain would be least felt. This defect in the invention having been remedied, it was proposed to try what effect a shell would have in destroying the barrier. With this view, an ordinary 8-inch shell, filled with about 3 lb. weight of gunpowder, was suspended from one of the rings of the portcullis let down from a groove in the brickwork of the archway at Fort Amherst. In order to give increased explosive force to the shell, and also to prevent any mischief arising from the pieces flying about, the portcullis was securely covered by a double row of planks. On the shell being exploded, its effect on the chain barrier was most complete; a portion of the barrier, about five feet square, being torn away, and the supports of the portcullis much damaged. It thus appears that although Captain Westmacott's invention is a most valuable one, and of sufficient yielding force to defy destruction by means of the ordinary charges of gunpowder, yet when a comparatively small quantity is exploded in a shell, the portcullis may be easily destroyed.—*Times*, May 14, 1858.

TERRY'S BREECH-LOADING RIFLED CARBINE AND PISTOL.

THIS weapon has been publicly tested. Mr. Terry, accompanied by Captain Tobias, of the German Legion, attended at the ground

adjoining Southsea Castle with the Rifled Carbine and Pistol and 200 rounds of ball-cartridge, soon after which the General and staff arrived and inspected the weapons and cartridge. Mr. Terry then loaded his carbine, an instrument only 18 inches in the barrel, and commenced firing at the 300 yards' range, accomplishing the firing of ten pounds a minute, putting in a vast number of centres. The General was evidently pleased, and having minutely examined the carbine after such rapid and effective discharges, found it to be as perfect, and the barrel as clean, as at the first shot. He then took the carbine, loaded it, and fired to satisfy himself, and made a centre hit. The next trial was with a rifled pistol, ten inches in the barrel, on the same principle. The General then desired Mr. Terry to fire at 200 yards' range, at which every shot would have knocked over a man or horse. After this demonstration of the power of carbine and pistol, so gratified were the instructing officers of the Enfield Rifle, that one gentleman requested that he might fire the carbine at 1000 yards' range, at the floating target off Southsea Castle, and at that distance he actually hit the target twice out of three times. This proof was conclusive.

A NEW BREECH-LOADING RIFLE.

A NEW species of Breech-loading Minié Rifle Musket, an American invention, has the calibre and weight similar to the ordinary muskets at present in use in our service. No derangement of the barrel is required in loading, the cartridge being applied through the medium of a small piece of mechanism, resembling a trap, over the lock. The cartridge bags are of metal, nicely fitting the chamber, and plugged with India-rubber, the centre of the plug containing the percussion cap; and the charge is guaranteed by the inventor to be secured from injury when exposed to any moisture, even under water. On preparing to reload, the action of raising the small cover at the breech withdraws the empty cartridge case, which is liable to the same amount of wear as the gun itself.

BLACKETT'S PATENT INACCESSIBLE LOCK.

TO obviate the access of burglars and lockpickers to safe-locks, either by boring tools, or by pick-locks or skeleton keys, an ingenious invention has been patented, by means of which any lock, and we presume almost any good iron safe of ordinary construction, may be greatly increased in security. By this invention, the boring of safe doors is rendered useless altogether to the burglar, while the lock is so placed as to present a formidable obstacle also to the use of pick-locks. The lock, of whatever kind, is affixed to the back of the safe, which is inserted usually into a wall, and not to the door at all, and is reached by the "key," or ward-traversing bit, through a tubular keyhole attached to a partition running through the safe from front to back, and containing a rod which acts the part of a handle to the "key," but never entirely quits the tubular keyhole, although it can be drawn backward and forward for the insertion and withdrawal of the "key" or bit. The keyhole is thus always occupied

by the rod, or handle, which may be massive enough to move the stiffest or most ponderous lock, such as cannot be tickled by the usual picker or skeleton key, even were it introduced. The lock acts at the back on an apparatus which catches the safe door by means of teeth both above and below, so that the usual tactics of the skilled lockpicker and burglar appear to be foiled.—*Builder*.

ITALIAN INFERNAL MACHINES.

THE Machines used by the Italian conspirators, in their diabolical attempt upon the life of the Emperor Napoleon in 1857, were constructed as follows:—Each consisted of a hollow iron cylinder, about 4 inches long and 2½ inches in diameter, divided into two transversely, and terminated at each end by a hemispherical cover. One of these covers was nearly 1 inch thick, and pierced with twenty-five apertures, over which fulminating caps were placed on the exterior. The other cover was considerably lighter, in order that when the missile was thrown from a window or elsewhere, the explosive end might with certainty strike the earth. The cylinder and covers were coated with bronze-colour paint, to conceal the brightness of the metal. The cylinder was filled with fulminate of mercury, or some explosive substance of equal intensity, in consequence of which the murderous manufacturers had taken great precautions in charging them. Instead of screwing the two parts of the cylinder together, which might have been dangerous, they merely placed one part within the other, and soldered round the joint on the outside. Other careful arrangements were also adopted. The explosive force of these terrible missiles may be conjectured from the fact, that the fulminating powder employed is fifty times more powerful in its effects than common gunpowder.—*Mechanics' Magazine*, No. 1799.

LONDON WATER SUPPLY.

DR. LANKESTER has communicated to the Royal Institution a paper "On the Drinking Waters of the Metropolis," the object of the lecture being to point out the nature and extent of the contaminations of Water used for the purpose of Drinking in London and its neighbourhood. Dr. Lankester commenced by considering Water as one of the great factors of the organic kingdom. Water is necessary to the formation of the tissues of both plants and animals. Some water-plants consist of from 90 to 95 per cent. of water; whilst Professor Owen has estimated the solid matter of a jelly-fish weighing two pounds, at sixteen grains. Seventy-eight parts in the hundred of blood, and seventy-two parts in the hundred of muscle, are water. Most kinds of solid human food contain more than 50 per cent. of water. The great source of water for organic life is the ocean, which, being carried into the atmosphere, is condensed, and falls on the earth in the form of snow, rain, and dews. Collecting on the earth, it forms rivers and springs, from whence man draws his supplies for drinking purposes. All waters contain more or less two sets of constituents, *inorganic* and *organic*. The principal inorganic *substances found in the* drinking waters of London are as follows:—

1. *Carbonate of Lime*, or chalk. This renders the waters hard, and is held in solution by carbonic acid. It can be removed by the addition of lime, a process invented by Dr. Clark, and carried on most successfully on a large scale at Plumstead. This process not only softens the water, but carries down the organic matters. This process may be applied with advantage to Thames water. 2. *Sulphate of Lime*. This salt is decomposed by organic matters, and gives off sulphuretted hydrogen. It is a frequent cause of the impurity of London waters. 3. *Chloride of Sodium* (common salt) exists in small quantities in the Thames, but in large quantities in the deep and surface wells. In the surface wells it is the result of the *débris* and the refuse of houses. 4. *Phosphates* and *Silica* exist in all the London waters, in small quantities. 5. *Ammonia* has also been detected in small quantities in the Thames, and in much larger and more appreciable quantities in the surface wells. This substance is the result of decomposition of animal matter; and in the surface wells is undoubtedly derived from human excretions. These substances are found in the Thames and the surface wells of London. It occurs as the result of the decomposition of animal matter. The surface wells are from ten to thirty feet in depth, and penetrate only the gravel lying above the clay, and thus receive all the percolated filth of the metropolis. 6. *Nitrates* are the result of the oxidation of ammonia, and are found in large quantities in some surface wells. In one water, examined by Mr. Noad, above 50 grains in the gallon were detected.

The *organic* matters were then described. They are both dead and living. They are better discovered by the microscope than by chemical re-agents. When fresh and living, they are not injurious, but when in a decomposing condition, they produce disease. Numerous instances were quoted where water charged with organic impurities had produced disease. Waters charged with organic matter have been shown by Noad and Medlock to act on lead, and thus to introduce this poison into the system. Dr. Medlock believes that all lead is taken up in water by the formation of soluble *nitrites of lead*. It was shown, however, that lead is dissolved in carefully-melted ice-water which contains no organic impurity, although it is not dissolved in water carefully re-distilled in contact with caustic potash. The living organisms of water were shown to be both plants and animals. Some plants and animals live amongst decomposing animal and vegetable matters. These were shown to be present both in the Thames and surface well waters. The eggs of higher forms of animals, some of which are inhabitants of the human body, are present in those waters.

As a means of purifying Thames water, the various methods of filtration were examined. It was shown that iron in contact with water, according to Dr. Medlock's experiments, is a great purifier of water.

The following conclusions were arrived at:—1. Uncontaminated water is necessary for the health of man.—2. Impure waters have been known to produce extensive disease.—3. The Thames water as now supplied is improved, but is still impure from the refuse of

towns passing into it, and requires filtering, or what is better, boiling and filtering, before it is used.—4. The surface well waters of London are altogether objectionable, as they give evidence of impurity in containing—1st, Carbonic acid in large quantities; 2nd, Chloride of sodium; 3rd, Ammonia; 4th, Nitrates; 5th, Living and dead organic matter.—5. Artesian or deep well waters are generally free from organic matters.—6. The chalk in the neighbourhood of London contains less saline matter than the deep wells directly under London.—7. Storing waters in lead cisterns is objectionable, as all natural waters are found occasionally to act on lead.

The composition of the Water supplied by eight of the Water Companies in the metropolis has been determined for the month of April, 1858, by Dr. Robert Dundas Thomson, F.R.S., of St. Thomas's Hospital, and is represented in the subsequent detail. It is proper to mention, that the water containing the largest amount of impurity happened to be taken after a fall of rain, when a distinct alteration in the composition of water derived from the surface drainage of an agricultural country can usually be detected. In this detail 1° (one degree) of impurity is equivalent to one grain of foreign matter present dissolved in the water per gallon. For the scale of comparison, water about to be supplied to Glasgow from Loch Katrine, and water supplied to Aberdeen from the Dee, are introduced:—

Companies.	Total Impurity. Grs. or deg.	Organic Impurity. Grs. or Deg.
Distilled Water	0·0	—
Loch Katrine	2·15	0·80
Aberdeen Water	4·0	1·75
East London	17·08	0·96
New River	17·48	1·68
Kent	27·29	3·52
Southwark	17·80	1·08
Lambeth	21·60	2·52
Chelsea	19·00	1·80
West Middlesex	19·92	1·96
Grand Junction	20·12	1·72

All the specimens were derived from the main pipes, with the exception of that of the New River, which was taken from a private tap in King William-street, City, and the Kent Company's sample, which was obtained from a house in Meeting-house-lane, Peckham.

PATENT APPARATUS FOR DISTILLING SEA WATER.

MR. W. H. GRAVELEY, of Upper East Smithfield, is introducing extensively into the ships of the merchant navy an improved Apparatus for Distilling Sea Water, to supply the ships' companies. The apparatus is divided into two parts, one being a boiler and the other a purifier or condenser, which, for convenience sake, fits over the boiler. He forms the surface of the bottom of the boiler corrugated in order to obtain as extended a heating surface as may be, and cases and packs the sides, or parts of the sides, to prevent loss of heat. *In the top of the boiler* is an aperture, and a pipe or tube *extending to near the top of* the condenser fits over or into it. Out-

side of this pipe he fixes another pipe, and thus forms an air space all round the pipe, which rises up and forms a continuation from the aperture in the boiler. The condenser is made of a dome shape, and is itself divided into two main compartments. Into one the salt or other water to be purified enters, and into the other the steam from the water in the boiler rises and becomes condensed by passing down through pipes fixed in the inner compartment containing the water to be purified. A pipe leads from the water supply chamber in the upper vessel into the boiler, and this and the boiler are fitted with suitable cocks. The steam, after being condensed, passes off through an outlet pipe into a filter, from whence it is to be drawn for use. For details, see *Mechanics' Magazine*, No. 1833.

SOUTH STAFFORDSHIRE WATER-WORKS.

THE works at Walsall and Lichfield have been inaugurated by Lord Ward. At the Pleck, reached from the Walsall station, an extensive open reservoir, covering six acres of land, twenty-one feet deep, and calculated to hold thirty millions of gallons of water, has been constructed. The reservoir, which is situated on the top of the Moat Hill, is almost circular in form, and is surrounded by a wide footpath; it has occupied about two years in formation, and its cost is about 8000*l.* At Sandyfield, on the way to Lichfield, the pumping engines are erected. They are placed in a building erected by Messrs. Branson and Gwyther, of Birmingham, and are two in number, of 150-horse power each, manufactured by Messrs. James Watt and Co., of Birmingham, at a cost of 20,000*l.* The reservoir at Lichfield is of enormous extent, occupying fifteen acres, and being capable of storing fifty millions of gallons of water, at a cost of 15,000*l.* in construction. The districts to be supplied are those of Walsall, Wednesbury, West Bromwich, and Dudley. The length of the cast-iron main between the engines at Lichfield and the town of Wednesbury is about 12½ miles. The branch of the Walsall reservoir is about half a mile, and to Wednesbury reservoir about the same, making a total length of 13½ miles. This has been laid by Messrs. Cochrane, of Woodside Iron Works, Dudley. The first five miles of pipes are 2 feet diameter, eight miles are 22 inches, and half a mile is 18 inches in diameter. About 7000 of these pipes have already been pumped through, and only two defective ones had to be replaced. The weight of main laid is upwards of 7000 tons, and when the branch mains to West Bromwich and Dudley are completed, the total length of main will be about twenty-five miles; through the whole of which the engines at Lichfield will pump the water, which is mainly derived from a tunnel of more than a mile in length, driven through sandstone rock teeming with water, and from shafts and borings sunk in the tunnel, as well as from surface drainage of soft water. The reservoirs in all hold about 90,000,000 gallons. The present works are capable of distributing *2,400,000 gallons* daily, and double that supply can be had if required. *At the lowest rates* known, the revenue from the present plant, if all

the water is sold, will realize 20,000*l.* per annum; and at that rate the cost to the humblest cottage will only be one farthing for a barrel of water containing thirty-six gallons. Mr. R. M'Clean is the engineer.—*Builder*, No. 823.

ORGAN BLOWN BY WATER-POWER.

In the *Year-Book of Facts*, 1858, p. 70, we described this novel application of water-power to the Organ of East Parade Chapel, Leeds. The invention has been extended to the organ of Carlisle cathedral, by Mr. Henry Willis, the patentee of the engine. The water is collected in two cisterns or tanks, placed in the roof over the south aisle, and is drawn from the reservoir supplying the town. From these cisterns the water passes down a pipe into two cylinders, like those of a steam-engine, standing in a hole apparently dug to obtain a greater fall of the water. Exactly over these cylinders are two feeders, made like the reservoirs of the organ bellows, each having a diaphragm or middle leaf which is moved up and down by means of the pistons. Attached to these leaves are two rods which pass down to two beautifully made and very large cocks. The reciprocating motion is attained by one cylinder operating upon the cock of the other, and the blast of air attained by these feeders is continuous, but varied by a steam equilibrium throttle valve, which the reservoir of the bellows closes as it becomes thoroughly inflated. The engine is under the immediate control of the organist, by suitable gearing leading to valves in the cistern.

MINING ENTERPRISE.

The deepest Coalpit in Great Britain, and probably in the world, has after nearly twelve years' labour, during which some important mining problems have been solved, been completed, and opened at Dunkinfield, Cheshire. The shaft of this extraordinary pit is 686½ yards deep, and the sinking of it has cost nearly 100,000*l.* The undertaking was commenced in 1847 by Mr. Francis Dunkinfield Palmer Astley, of Tilefoot, Cumberland, who is lord of the manor of Dunkinfield, a township of 1263 acres in extent, and containing valuable beds of coal. By September, 1848, the shaft of the pit had been sunk 220 yards, when the works were stopped by the tapping of a copious spring of water, which rendered it necessary to put in pumps and drive a tunnel 80 yards long. In about fourteen months this work was completed, and 43 yards added to the depth of the pit. Shortly afterwards another spring was encountered, which stopped the works three months. At the end of five years from the commencement, a depth of 476 yards had been attained, the last 163 yards having occupied twenty-nine months, in consequence of the difficulties which had to be overcome, the rock pierced through being very hard, and another tunnel 400 yards long having had to be made. At this point the sinking of the shaft was suspended for a time, and the mine was worked for coal; but in 1857 it was determined to sink the shaft to the Black-mine, a further depth of 216½ yards. Operations proceeded steadily in the face of many difficulties and dis-

couraging predictions; but the enterprise was successfully completed last week by the workmen winning the Black-mine, a fine seam of coal 4 ft. 8½ in. thick, and calculated to last thirty years, at 500 tons per day. In sinking the shaft, twenty-two workable seams of coal were passed through, as well as eight other seams, varying from 1 to 6 feet thick, and in the aggregate 105 feet in thickness. The shaft is generally 12 ft. 6 in. in diameter, but near the bottom it expands to a diameter of 19 ft. 2 in. It is lined with bricks 9 inches thick, with strong rings of stone at intervals of 8 yards. At the bottom of the shaft is an incline nearly half a mile long. The pit is fitted with very powerful machinery. Another shaft of the same depth is sunk as an air draught.—*Times*, July 1, 1858.

MINERS AND WASTE OF LIFE.

A RECENT Parliamentary Paper shows that there are no fewer than 230,000 persons employed in the Coal Mines of Great Britain. A marked improvement has taken place in the manners and extent of knowledge of this useful body of workers, and it is gratifying to learn that in the Wakefield and Methley district a combination of the men has been made for the purpose of raising funds for investment in coal mines and other safe ventures, the proceeds of which are to provide for sickness, and such other ills, to which this class of men are more liable than some others. The necessity of means of relief in case of sickness or violent death is shown by the following figures: —In 1851, the number of lives lost was 984; in 1852, 986; in 1853, 957; in 1854, 1045; in 1855, 963; in 1856, 1027; in 1857, 1119. *Seven thousand and eighty lives lost in seven years.*

It is noticeable that no class of men have so often differed with their employers on the matter of wages as the coal-miners of Northumberland and Durham, and it is feared that these have not been for the benefit of the workers. The men, however, say that the colliery proprietors themselves set the example of combination by forming a sort of corporation to limit the quantity of coal wrought in certain districts. The duration of the lives of the pitmen is short, and the great per-centage of what are called accidental deaths shows the necessity of provision for families; while it is stated that at the present time those who work in the deep darkness of the mines, in an unwholesome atmosphere, are paid for all this risk of life at the rate of 3*s.* 6*d.* per day during six days in the week. This seems a small payment for the amount of skill which is required, and the danger. It is, however, clear that in this description of labour, as in others, the rate of wages will be regulated by the proportion supply bears to the demand.

The number of accidental deaths is a matter for the serious consideration of all; and it has been hinted to us that if the lives lost in the coal-pits were charged to the owners in the same way that accidents are laid to the charge of railway companies, instead of *the thousand lives lost* each year in the coal mines, we should have *but a tithe of the number* of deaths.—*Builder*, No. 823.

COAL TRADE OF THE UNITED KINGDOM.

	No. of Collieries.	Tons of Coal raised.
Durham and Northumberland	268	15,826,525
Cumberland	28	942,018
Yorkshire	374	8,875,440
Derbyshire and Nottinghamshire	194	3,687,442
Warwickshire	16	398,000
Leicestershire	14	698,750
Staffordshire and Worcestershire	563	7,164,625
Lancashire	359	8,565,500
Cheshire	31	750,500
Shropshire	55	750,000
Gloucestershire, Somersetshire, and Devonshire	99	1,225,000
North Wales	84	1,046,500
South Wales	325	7,132,304
Scotland	425	8,211,473
Ireland	70	120,630
	2095	65,394,707

MACHINERY FOR THE MINES OF CORNWALL.

In the discussion which followed the reading to the Institution of Civil Engineers of a paper by Mr. Henderson, "On the Methods generally employed in Cornwall, in dressing Tin and Copper Ores," allusion was made to Oxland's process for removing wolfram from tin, as practised at the Drake Walls Tin Mine. The tin-stuff being roasted with soda, the wolfram combines with it, and forms tungstate of soda, which being soluble in water, can easily be removed. This is important, as it appears probable that tungsten will be, by Jacob's process, rendered available in the manufacture of steel, and will be used in the arts generally.

The universal feeling among the better informed "dressing captains" in Cornwall is, that the present methods of dressing ores, requiring a large proportion of manual labour, are a reflection on the mechanical progress of the age. Mr. Herbert Mackworth's machine for washing coal, by a slow, continuously ascending current of water (of which six specimens have been at work since May, 1857), is said to be almost automatic. The difference in the specific gravity of shale and coal being as 2·6 to 1·3, there will evidently be less difficulty in separating the ordinary minerals of Cornwall, and experiments on a small scale promise successful results.

The deficiencies of the present processes in Cornwall are admitted, and it is suggested that the great point is to continue the crushed and triturated stuff from the stamps in constant progress onwards, through all its stages, so that the mass shall not be allowed to come to rest; this, it is urged, is very practicable, wherever there are copious supplies of water, and the machinery is improved with that object in view. Upon this principle the success of the coal-washing machine is based. Great improvements have been introduced into the machines in the Austrian mines, and very successful results have been obtained. It was shown, that it is not desirable to reduce

some ores to too fine a powder; this error has been committed in some of the gold-crushing mills, and to this must, in some degree, be attributed the failures that occurred during the gold mania.

It is practicable to extract with profit minute fractions of gold from a poor matrix. A mine in Hungary was instanced, whence, from a depth of 200 fathoms, the gold matrix is raised, and so skilfully manipulated as to work at a profit, although only producing one-tenth of an ounce of gold from a ton of the matrix.

COPPER SMELTING.

MR. HYDE CLARKE has read to the Society of Arts, a comprehensive paper of great practical value on the manufacture and extent of this important branch of British art and commerce. Mr. Clarke pointed out that Copper Smelting is of importance in England, not only because we smelt our ores, but because we have also a large business in smelting foreign ores and refining foreign copper. Although English copper mines do not produce very rich ores, they yield such as can be easily smelted, and the advantage of cheap fuel enables us to undertake the smelting of the rich ores of other countries on better terms than they can themselves. It is further to be noticed that France, Belgium, and Holland are almost destitute of copper mines; so that the English have an opening there for manufactured copper, and can compete in Central Europe with the Russian copper. Mr. Clarke stated it as his opinion, however, that with all these advantages it is still to be questioned whether the English copper trade has reached its height or is free from vicissitudes. He thought the practice of smelting by coal in reverberatory furnaces not the most economical method. Moreover, it is quite possible, looking to the effective establishment of copper smelting in Chili, the United States, and Australia, to the abundant supply of rich copper ores abroad, and the importation of very cheap iron, that copper might be reduced in price, and the working of the Cornish mines be threatened; but, on the other hand, if processes were adopted for the more economical reduction of copper, ores of lower produce could then be brought to market. At present, copper smelting is a routine work, followed out as a mechanical practice rather than as a scientific operation; but it is continually undergoing modifications. The copper smelting trade began in Cornwall, and was thence removed to South Wales, which until lately remained its sole seat, as it was its chief seat; but Liverpool, having a great import of foreign and colonial copper ores and bar copper, has favoured the establishment of smelting works on the Mersey, and now has a copper market which is yearly growing into importance. The author proceeded to give a detailed account of the various processes employed in the treatment of copper ores. The first process is called sampling, and consists in separating the various qualities of ore, which are then dried, and, if consisting of sulphurets, are calcined, to get rid of some of the superfluous sulphur. The ore is then placed in the reverberatory furnace, the construction and management of which the author described in considerable detail. The

coarse metal produced by the last-mentioned process requires further calcining, and for this purpose an arrangement, suggested by Napier, and further improved by Mr. Alfred Trueman, is employed. This calcined coarse metal is then melted, the result being the production of blue or fine metal, and sharp slag. The fine metal is then roasted, frequently twice, and afterwards placed in the refining furnace, and finally cast into ingots, tiles, or wire bars, according to the demand.

STRENGTH OF ALLOYS OF NICKEL AND IRON.

MR. W. FAIRBAIRN has read to the Manchester Society, a paper on "Experiments to determine the Strength of some Alloys of Nickel and Iron, similar in composition to Meteoric Iron." The object of the experiments in this paper was to ascertain whether an infusion of nickel, in a given proportion, would increase the tenacity of cast-iron, as originally imagined from the analysis of meteoric iron, found to contain 2½ per cent. of nickel. Contrary to expectation, the cast-iron, when mixed with the precise quantity of nickel indicated by the analysis of meteoric iron, lost considerably in point of strength, instead of gaining by it. Hopes were entertained that increased toughness and ductility would be the result of the mixture; but the experiments which follow clearly show that there is a diminution in place of an increase of strength.

This improvement has reference, independent of other objects, to increased tenacity in the metal employed for the casting of mortars and heavy ordnance. During the last two years innumerable tests and experiments have been made for this purpose, with more or less success; but the ultimate result appears to be, in the opinion of the author and others, that for the casting, or rather the construction of heavy artillery, there is no metal so well calculated to resist the action of gunpowder as a perfectly homogeneous mass of *the best and purest cast iron* when freed from sulphur and phosphorus.

In the discussion which followed the reading of the paper, Mr. Calvert said that it was highly probable that nickel caused the increased brittleness of cast-iron, just as carbon, phosphorus, and sulphur, but that the result with malleable iron might probably be very different; and as meteoric iron is malleable, the trial could only be complete when soft iron and nickel were united; nevertheless, these experiments, as far as cast-iron is concerned, were decidedly new and of great value.

HOWELL'S HOMOGENEOUS METAL.

MR. HOWELL has exhibited to the Society of Arts, a specimen of his Homogeneous Metal, which, he states, is perfectly malleable, and possesses all the strength of fused metal, but is free from lamination, and combines perfect ductility with the greatest tensile strength. This is a malleable iron, fused in pots, and melted in masses sufficiently large for the manufacture of blocks and sheets from one ton to ten tons each in weight, and these are in all respects as sound and as regular as the specimen he now exhibited. The tensile strength of this metal *is to be depended* upon up to fifty tons per square inch, *and when punched* there is no liability to shatter. It is in fact cast

steel, but without its brittleness. It is pure iron as nearly as it can be made, means being employed to free it from the impurities which were known to exist in bar iron. Mr. Howell mentioned several of the uses to which this homogeneous metal has been applied; amongst others, for multitubular boilers, coupling chains, &c. The little steam-vessel taken out with the Expedition of Dr. Livingstone is constructed of this material, the plates being only one-tenth of an inch in thickness, and these are found to be stronger than the ordinary one-eighth plates used in ship-building. In reply to an inquiry, Mr. Howell added that the cost of this metal is 50*l.* per ton, but, from so much less weight being necessary, the expense is not much greater than that of the ordinary plates.

IMPROVEMENTS IN THE MANUFACTURE OF STEEL.

We have recently received from our Correspondent in New York a letter stating that the Damascus Steel and Iron Company, of that city, were producing steel of every description and quality at prices very much below the current prices of the English and American markets. We have now before us a document emanating from the Company, in which they state that they are enabled to make cast steel of the very best qualities, in any quantity, and invariably uniform in every respect. The following extract from the document sets forth their objects and professions as far as they have seen fit to publish them:—

By the old process, from fifteen to twenty days' time is required to convert iron into steel; and whether the steel produced be good or bad, depends more on the experience of the master and the practical skill of the workman, than on any well-defined laws of science. The steel maker has, in the first place, to possess a very intimate knowledge of the exact intrinsic qualities of the iron he uses; he has to secure as complete and as equal a degree of carbonization as possible; he has to know that the steel he makes is equal in hardness, in which, without much practice, he may very easily be deceived; and finally, after all, he must examine its fracture by breaking off the end of each ingot, and then trust to his judgment to come to a conclusion whether or not proper care has been taken. It is owing to the absolute necessity for the constant exercise of all these requisites, that not unfrequently we find steel, from even the very best makers, not give satisfaction; and in all such cases, disappointments and losses of course ensue.

Besides all the knowledge and care we have spoken of, the duties of a steel maker go yet a good deal further; he must adapt the capabilities of his steel to the wants and requirements of the consumer. There are a vast variety of defects in steel as usually manufactured, but there are a far greater number of instances in which steel is not adapted for the manufacture of the article for which it was expressly made. Cast steel may be manufactured for planing, boring, or turning tools; its defects may be, that the tools when made crack in the process of hardening, or that the tool while exceedingly strong in one part, will be found in another part utterly worthless. A vast number and variety of other instances might also be cited, where cast steel is manufactured, even by skilful persons, and for want of a proper knowledge of the treatment the steel will receive after it leaves his control, it is found more or less unsuitable. The steel maker then, being required not only to attend to the intrinsic qualities of his steel, but also to trust to his judgment on so many points, particularly as regards the degree of hardness and tenacity which it should possess, so as to adapt it to the peculiar requisites of its employment, it is very evident that any system whereby some share of this responsibility might be transferred from the domain of chance and hap-hazard, to that of science, *would be most desirable.* This change is precisely what is effected by the new *process of steel manufacturing, as successfully carried out by the Damascus Steel and Iron Company.*

Under this process, although skill and practical experience in the workmen are always important qualifications, and will continue so to be under any system, yet all the essential processes and manipulations whereby any required quality or temper of steel is designed to be produced, are taken out of his hands; and with them, all the risks of any failure in the results that might otherwise arise from either ignorance or carelessness. The new process combines, in one operation, the thorough refining of the iron, and the imparting to it just the proportion of carbon required for any particular quality of steel. It will thus be seen that it surpasses the old, tedious, and expensive 'cementation process,' with all its vexatious and uncertain results. The efficiency of the refining flux which is added to the metal, is sufficiently proved by the change that takes place in the iron when the carbonizing ingredients are altogether omitted. This change is manifested by a great increase in strength and tenacity, such as is unapproached by iron treated in any other way.

This truly scientific and simple process is all that has to be gone through in converting the iron bar into the steel ingot. The after-manipulations of reheating, hammering, &c. &c., are, of course, conducted in the usual way. It will thus be seen, that it is on the proper understanding of his business by the manager, and on that alone, the success of the whole manufacture hangs; and that it is not, as by the old process, left to the judgment of persons who may at any time ruin all, either by negligence, ignorance, or wilfulness. One of the main features to which it is especially designed to call attention, is that the quality of the steel to be produced is *known* to a certainty *before* the crucible is put into the furnace, and not, as in the old process, left to be *guessed* at by breaking off the end of the ingot when cast. This, it is believed, must commend the Damascus Company's product to every user of an article like steel, which, to be of any value at all, is required to be of exactly uniform quality.

We quote the above from the *Mechanics' Magazine*, No. 1840. The Editor adds: The testimonials received are strongly in favour of the Company's steel. From the patentee we learn that sal ammoniac and cyanogen are the principal materials used in this process, which, if the results promised by it are attained, will, to a great extent, revolutionize the steel trade.

BESSEMER'S IRON AND STEEL PROCESSES.

Mr. Bessemer's Process does not seem to have become quite a dead letter. It is understood that the manufacture of Iron and Steel is being now successfully carried on in Sweden upon the above system; and Messrs. Bessemer and Co. are engaged experimentally in Sheffield in the production of steel by their new process.

From a letter in the *Daily News*, written by a Swedish ironmaster, Mr. G. F. Goransson, it appears that the Bessemer process of converting molten pig iron into steel without additional fuel, and in a few minutes, by the infusion of an air blast, has, after various costly failures, been successfully put into practice on the great scale in Sweden, and precisely as Mr. Bessemer proposed or instructed. Mr. Goransson, when the news "spread like a huge wave over the whole Continent of Europe," hurried over to England, witnessed Mr. Bessemer's experimental exhibition at Baxter House, and on his return home immediately set to work, and allowed no failure to daunt him till the process became familiarized to his workmen and himself; and "so completely have we accomplished this object," says he, "that we now make several hundred large ingots of cast steel in succession *without a single* mishap or failure of any kind. The steel *can be made either hard*, medium, or soft, at pleasure. It draws

under the hammer perfectly sound and free from cracks, flaws, or faults of any kind, and has the property of welding in a most remarkable degree. Steel so made has now been manufactured into cutlery of the first quality, and into every variety of tools for the engineer, as well as for boiler plates of large dimensions. Our firm has now entirely given up the manufacture of bar iron, which it had carried on for so many years, and our blast furnaces and tilt mills are now wholly employed in making steel by the Bessemer process, which may, therefore, be now considered an accomplished commercial fact, which can no longer admit of question on theoretical grounds; and it is both with pride and pleasure that I find that our firm in Sweden has been the first to have carried out Mr. Bessemer's invention to its fullest extent, by producing ingots of cast steel of most excellent quality from the molten crude iron, within ten minutes of its leaving the blast furnace, wholly without manipulation or the use of fuel, and also without ever having had recourse to any one of the numerous plans that have been patented by others, under the idea of improving Mr. Bessemer's most simple and effective process. The loss of weight, including the carbon and other impurities given off, varies from 12 to 15 per cent., or about one-half of the waste incurred in the old system of making bar iron in Sweden." By its means he can "produce annually more than 1000 tons of so valuable an article as cast steel with the same quantity of fuel only as is now consumed in the production of 500 tons of bar iron by the process now in general use."

PRESERVATION OF METALS FROM OXIDATION.

As a ground-colour for iron, red paint is not only very expensive, but not lasting. Many substitutes have been proposed, but the results bear no proportion to the great cost. It has, consequently, been a most important object to invent a composition which, from its chemical properties, would really prevent the oxidation of iron, be more economical, cover a much larger surface than red paint, be easily laid on, suitable to all purposes and climates, able to resist cold, heat, acids, damp weather, salt water, &c., and be more permanent in its effects than any hitherto known anti-corrosion paint. To obtain these incalculable advantages, experiments, extending over a number of years, have resulted in the patented composition, "Grey Minium;" and from the experience which has been arrived at by observing its qualities as a preservative against the corrosion of metals, added to the highly favourable testimonials from chemists of repute, after testing it, the patentees, Messrs. Dodd and Co., of Newcastle-upon-Tyne, expect that this new patent will completely supersede all other pigments for iron.

This composition, when applied once or twice, has a beautiful and polished lustre of a dark olive colour; it dries quickly (covering the iron with a glazed, compact, and tenaciously adhesive coating); possesses the properties of neither running, blistering, cracking, nor peeling off; has a great affinity to iron (with which it seems to unite itself most intimately), and, consequently, when the clea-

ginous matters which it contains have become decomposed by the action of the sun, air, or rain, the colour remains, preserving the object to which it may have been applied—as by a hard protecting skin or impenetrable coating—and rendering it much more durable than galvanized iron. Experience has likewise proved that, when iron-work has been covered with this colour, it has preserved it many years from oxidation.

MALLET'S 36-INCH MORTARS.

THESE gigantic Mortars were described in the *Year-Book of Facts*, 1858, pp. 15-16. Additional trials have been made with them. One of the experiments, in July, in Woolwich Marsh, commenced at 11 o'clock, and terminated at 1.30, with a charge of 50 lb. of powder, &c., which obtained a range, as on the former occasions, of about 340 yards to each 10 lb. of powder. A minute examination of the wedges, keys, rings, &c., having been made and pronounced "all right," a second charge of 60 lb. of powder, &c., was introduced. The second round, like the first, was highly successful, the range in this instance exceeding 2000 yards, the shell alighting beyond the butt, in a ditch which separates the marsh from the adjoining property, and creating a tremendous eruption of water, black earth, &c. According to the prescribed arrangement of adding 10 lb. of powder to each successive charge, the third round contained 70 lb.; and although the monster gun had stood the first two rounds well, an additional degree of caution was observed by every one present to stand clear of its proximity the instant the match was ignited. The effect of the third round was less successful, as one of the steel cotters broke asunder, and was rendered useless; but as the former experiments had shown the necessity of being provided against a similar casualty, the broken key was replaced, with some slight delay, by a second, wrought of malleable cast-iron, supposed to be more durable. The mortar was then reloaded with an 80 lb. charge, and fired with apparent success, the shell again mounting high in the air, and taking a flight over 2758 yards, considerably exceeding a mile and a half. The elevation of the mortar was frequently varied, and was ultimately reduced from 48 deg. 30 min. to 45 deg. At this stage of the proceedings it was found impossible to carry on the experiments, as one of the mainstays intended to secure the various segments constituting the barrel of the mortar was broken, and one of the principal wedges or cotters, a foot and a half in length, had escaped.

SILVER IN BELLS.

THE public have heard more or less about the liberal use of Silver in Bell-metal, and how some apocryphal bells are supposed to contain at least half their weight of this precious alloy—a myth in which many people persist in believing even down to the present day. But silver is not a sonorous metal; and from experiments made with standard *silver bells, it* has been shown, beyond dispute, that they *have very little sound,* and that little, too, is of the harshest and

most unmusical kind. With a view of definitely testing the effect of a slight admixture of silver upon the tone of a bell, Messrs. Mears made four very small ones of the same metal as the great Bell for the Westminster clock. In one of these 1*s.* 6*d.* worth of silver was put, in another 1*s.* worth, in the third 6*d.* worth, and in the fourth none. The mischievous effects of even this slight quantity of silver were here clearly shown; for that which had the least amount in it was the least injured in tone, and that which had none was the best sounding bell of all. It was fortunate that this was the actual result, for had it been the reverse, it would have been a costly failure. To produce an appreciable effect on the note of the bell of Westminster, even supposing that so small a quantity as one shilling's worth was melted with each pound of bell-metal, the cost of even this slight admixture would amount to no less than 1600*l.* sterling.

THE DONCASTER BELLS.

THE New Peal of the new parish church of Doncaster has been rung by several sets of ringers, both professional and amateurs, Mr. Denison, Q.C., who designed them, ringing the tenor bell, after the example of Sir Matthew Hale. This peal has excited unusual interest from its being cast on a new principle in several respects, especially in the large bells being much heavier than usual for their note, and in proportion to the smaller ones. The tenor is exactly half the size of St. Stephen at Westminster, and very nearly of the same shape and composition. It weighs 30 cwt. 1 qr., and the note is E flat, concert pitch; the treble (an octave higher) is 6½ cwt. Nevertheless, the small bells are perfectly distinct, and are not at all overpowered by the large ones, and the whole peal is pronounced unusually fine, sweet, and brilliant in tone. The casting has also been noticed by the authorities in such matters as particularly good; and, altogether, the success of these two great works in bell-founding—the St. Stephen of Mr. Mears and these 12 other bells of Messrs. Warner, afford good ground for believing that this art, which a few years ago appeared to have fallen very low, is undergoing a revival.

THE GREAT BELL FOR THE WESTMINSTER CLOCK.—THE RAISING.

THE Westminster Bell and the *Great Eastern* steam-ship have been the standing wonders of years; and numerous have been the statements and counter-statements as to the actual state of those mechanical marvels.

In the *Year-Book of Facts*, 1858, p. 111, we left the first Great Bell cracked in the sounding, before it was attempted to be raised. It was then broken into pieces, and carted away to Messrs Mears' foundry in Whitechapel, where it has been recast; and on May 28, the new bell was conveyed to the base of the clock-tower at Westminster. There are 2½ tons less metal in the present bell than in the former; its dimensions are less, and its form slightly different.

The head is more rounded and the waist more sloped in. The sound-line, or place on which the clapper strikes, is also half an inch less in thickness than that of the old Bell. The upper parts of the new Bell are as sound as those at the very bottom. There are no holes, no symptoms of unsoundness or cracks, and no refuse of the furnace on the collar to tell that the metal was too rigidly economized. Everything is exactly as it was wished, and Mr. Denison expresses himself satisfied that both in tone and manufacture it is excellent. The unexpected thickness of metal in one part of the old bell caused its note to alter from what was intended from E to E natural. With the present bell no accident of this kind occurred, mainly owing to hot air being blown into the mould during the whole day of casting, thus preventing the sudden cooling of the surface of the metal and the porosity to which large castings in cold moulds are liable. The clapper of the new bell is about half the weight of the one originally cast, being about 6 cwt. instead of 12 cwt. as formerly. The bell has finally been named "St. Stephen." It spoke on November 18th for the first time. It was struck with the clapper, Mr. Denison pulling the rope. "The first stroke was slight, but afterwards it came peal after peal in a tremendous volume of sound that was actually painful. Many persons went upon the balustrade outside the chamber to avoid the waves of sound that seemed eddying round the tower; but the escape was only a partial relief, the great din seeming almost to penetrate the stone-work of the battlements, and jar the very place in which one stood." The note of the new Bell is said to be nearer the true E natural than that of the first Bell; the four quarter bells are E, F, G, and B respectively, and the musical arrangement of the chimes is—For the first quarter, G F E B; half-hour, E G F B—E F G E; three-quarter, G E F B —B F G E—G F E B; and for the hour, E G E B—E F G E—G E F B—B F G E, after which the great bell will peal forth the hour with its full sonorous note the octave below the last chime.

The raising of St. Stephen was a labour of great interest, which is thus ably detailed in the *Builder*, No. 816:

In the first place, in the centre of the tower, from the foundations to the clock-room, is a shaft, 11 feet 2 inches by 8 feet 6 inches, provided for the descent of the weights of the clock. Communicating with the bottom of this shaft, on the western side of the tower, and close to where the bells were tried, is a large archway, through which the bell, on the bed of a "cradle," travelled to the bottom of the ascending-shaft. The diameter of the bell at the mouth being somewhat greater than the breadth of the ascending-shaft, the bell had to be thrown over on its side on the cradle before entering the archway. When the bed of the cradle had been run into the bottom of the shaft, the sides and top of the cradling were bolted up together, and the centre of gravity of the whole was ascertained: the bell being on its side, causing the centre of gravity to deviate considerably from the centre of the cradle. The shaft was fitted from the bottom to the top with timber guides for the cradle, against which large friction wheels, attached to the top and bottom of the cradling, ran. Everything being thus ready at the bottom, the bell in its cradling was hoisted up this shaft by men, and powerful gearing, prepared for the purpose. On a massive carriage and staging, near the open lantern of the roof of the tower, had been constructed a beam of wood and wrought iron, made by bolting between three thicknesses of wood, two thicknesses of wrought iron—in the whole 25 inches deep and 19 inches thick, and proved to 100 tons. Around this beam, near the centre, had also been fitted an iron strap and shackle, so

arranged as to be adjusted when the centre of gravity on the cradle had been ascertained below, so that the top block should be perpendicular over the point already decided on in the cradle. Immediately behind this beam was fixed a powerful crab constructed for this purpose, with extra powers and breaks. The chain was wound around the drum of this crab four times before starting, and the end of the chain carried over the drum of a second crab in the same manner, at a lower level in the tower, for the purpose of taking up the slack from the first crab, previous to coiling, as it passed off the drums. As the chain would not accumulate on the drum, but pass, when winding, from one end of the drum to the other in ten revolutions of the drum, a click, or stopper, was constructed, to be quickly applied to the chain, to take the weight off the crab. When the chain had wound itself to the end of the drum, the men simply slid the chain back to the other end of the drum; the crab again took up its work; and the stopper being again released, the same operation was applied to the entire height. The clock-room was the first landing, as the shaft there ceases. The bell in this room was taken out of its cradle, turned mouth downwards, hoisted in that position the remainder of the height, and put on packings previous to its being finally fixed to the bell-carriage already prepared for the purpose. During the whole of the operation, the exact height the bell was up the shaft could be easily seen by a line marked in heights from the cradle at the bottom: it passed over a pulley in the bell-chamber with a counter-weight attached. The chain for the hoisting was reeved through two treble blocks, with one fixed end, making seven reevings. The entire length of the chain was between 1500 and 1600 feet. Every precaution that could be devised for the safe landing of this monster on the tower was adopted. The circumstance is peculiar, that no one could by any means interfere with or even see the bell from the time it left the ground until it made its appearance in the clock-room. The iron for the chain was made expressly for the purpose by Messrs. Crawshay, of Newcastle, and tested previously to its being manufactured by them into chain; and every link of the chain, we are told, was tested and examined by Mr. Quarm, the able chief clerk of the works at the New Palace at Westminster, and Mr. James, of Broadwall, at the manufactory of Messrs. Crawshay, at Newcastle, previous to its being sent to London; Mr. James having been appointed to execute the work required for the hoisting of this enormous bell, under the immediate directions and superintendence of Mr. Quarm.

The machinery for raising is admirably illustrated in the *Builder*, No. 816. It reached its first resting-place, on the floor of the clock-chamber, on October 14,—thirty-two hours having been occupied in raising it to the height of 185 feet. It was next taken out of the wooden cradle, and raised to its final position, at within a few inches of 200 feet from the ground, measuring to the crown of the bell.

The following additional details accompany the admirably illustrative Engraving in the *Builder:*

Besides the principal crab, there was a smaller one, as already mentioned: this was placed at the floor of the bell-chamber; and it worked (through a block, secured below at the clock-chamber, to a strong wooden beam temporarily placed) a second and smaller chain, which passed again upwards, and had its end attached to the fall or waste of the main-chain, in the first instance, at a convenient point below the drum of the large crab; so that the fall was drawn down to the floor of the clock-chamber, where it was coiled up—having done its work. The end of the smaller chain was refixed, as was necessary, to the larger chain. The weight of the bell was really resisted by the friction on the drum of the large crab, added to the weight of the back or fall-chain, rather than by the second chain, which is not kept *taut*, though sufficiently so to serve in case of accident at the great crab. Close watching was required at the winding of the chain, to prevent "riding" of the chain and a consequent jerk.

The weight of the bell, of course, was distributed over several multiples of the chain, according to the number of reevings, rather than borne by the chain viewed *singly as it reached the* drum.

The contrivance for taking the weight off the crab when the coil of chain *reached the end of the* drum (at intervals of about an hour and a quarter), or in

order that the chain might be shifted, and the work begin afresh, was a simple and ingenious one. It was a clip for the chain, cast in two halves, to be screwed together, and, as it were, moulded at the meeting parts, to receive one or two links of the chain. The halves being made secure, the connected block was then wedged up: the weight could thus be taken off the crab, and the alteration at the drum be made as before mentioned. The whole operation did not require more than three or four minutes. The contrivance has become known as the "Quarm *clip-stopper*." The details of the mechanism reflect credit upon Mr. Quarm; as also does the success of the hoisting, upon him and others.

Thus have been negatived the many gossiping statements, by which the public were "given to understand, from time to time, through letters and articles published in some of the widely-circulated leading journals, by persons who had not given themselves the trouble to ascertain facts beforehand, that Sir Charles Barry had provided no means by which the clock or bells could be put into the tower; one in particular stating that the only possible mode of admission was through the windows." When the moment had arrived, and the bells were ready for hoisting, it was plainly seen that nothing that forethought could provide had been omitted.

THE ILLUMINATED EXCHANGE CLOCK, LEICESTER.

This new Clock possesses certain advantages, which are thus described in the *Leicester Journal:*

One of the chief features in the frame—which differs considerably from those ordinarily used—is, that it need never be taken to pieces to remove any of the works if they should require repair, as they are so arranged that all the wheels may be taken out by unscrewing the pivot-hole bushes. The clock is kept going whilst being wound up by the going ratchet plan, which has the advantage over the bolt and shutter generally used, of always being set up by the clockweight instead of by the person winding it, who may forget to do so, and likewise of removing the supplemental force from the clock so soon as it is wound up.

The pendulum is compensated with mercury for the change of temperature from winter to summer, and consists of a strong glass cylinder, closed at the top and bottom with stuffing-boxes for the steel rod to pass through. It contains 98 lb. of mercury, occupying the proper height in the cylinder for its expansion upward, to exactly counteract the expansion of the rod downward, and keep the radius of oscillation the same. The regulating nut is divided into seconds, and small regulating weights are added on the rod for the more minute division of time. The suspension-spring is only three-tenths of an inch long between the clamps, instead of an inch or two, as generally employed; it is an inch and a half wide, but only 66-10,000ths of an inch thick, and was selected from a long piece by measuring across the width in action with a very delicate micrometer to the 10,000th of an inch, which is about the thickness of a fine human hair split into thirty parts. The same accuracy was observed to make the plates clamp the spring evenly all along the edges, and at a right angle to the perpendicular of the pendulum; to have the centre of the spring in the centre of the rod, and the top rod and cylinder all concentric with each other; to make the plane of motion of the crutch parallel to the plane of the pendulum, and both centres of motion to coincide. The result is that, now the pendulum is in action, it vibrates so truly in the same plane that the sensitive surface of the mercury betrays no tremor, although it is so delicate a test that a light cart passing within fifty yards of the Exchange causes a perceptible undulation.

Connected with the pendulum is the isochronous arc spring, which causes the long and short vibrations to be performed in the same time; so that whether the clock is clean or dirty, and the oil fluid or frozen, the clock will keep the same time. This is effected by the spring being drawn more into action the further the pendulum swings, and communicating just as much impulse to the pendulum as will enable it to perform the long journey in the same time as the short one.

The hammers are much heavier than it would be prudent to use on a bell of this size if it were a good one; but the bell being too small, and having a very bad tone, as much sound has been got out of it as possible.

The illumination of the clock is effected by a new method, with two large lenses placed before the burners, which are connected by a pierced tube of jets, so as to light one burner from the other if either should go out during the day, when the gas is turned very low. A hood connected with a pipe is placed over the gas, which carries off the vapour of combustion, and perfectly ventilates the dial-room. The appearance of the dial is much superior to the usual method, by night as well as by day, as the illumination is easily diffused over the dial, without glare, or the position of the burners being distinguishable in any part. The full illumination is kept on until half-past eleven, when the gas is turned half down for the rest of the night, leaving only sufficient light to enable the time to be easily distinguished; at daylight it is turned down a stage lower, when the flame will not be higher than is necessary to keep it from going out. These points have been ascertained by experiments, and stops placed in connexion with a tap on the ground floor, by which the gas may be turned exactly to the right place in the dark. The former clock used to be illuminated until half-past eleven, when the gas was turned quite out, and the man had to ascend to the top of the building to relight it every night, yet the consumption of gas for the few hours' burning under the old system was about twice as much as the present system consumes burning day and night; the former illumination must not, however, be censured as an extravagant instance, for it is laid down as a rule under the old system that the annual expense of illumination is much greater than the interest of money on the whole outlay for the clock.

THE WARMING OF ST. PAUL'S CATHEDRAL.

THE Warming of St. Paul's Cathedral, which contains about five millions of cubic feet of air, for the special services beneath the great dome, being the greatest undertaking of the kind that has yet been attempted, we are induced to give our readers a short description of the process adopted.

The work was undertaken by the London Warming and Ventilating Company, Great George-street, Westminster, and is now complete, so far as the nave of the cathedral is concerned. The nave forms nearly one-third of the cathedral, and the warming of it has been perfectly successful. For the purpose of trial it was cut off from the dome by curtains of glazed calico, and the crypt below was also cut off at the same point with sail-cloth. The stoves, six in number, constructed according to Mr. Goldsworthy Gurney's patent, are in the crypt, and are found to be far from expensive, and amply sufficient for this portion of the building. When the arrangements were completed, the crypt, and of course the whole of the cathedral, were each thrown into one entire space, the two communicating with each other through the gratings in the floor of the cathedral. These gratings are so arranged that a certain and constant number of them serve as up-casts, and the remainder down-casts, with the power of turning the whole into up-casts during the time in which large congregations are assembled. At this time a full supply of fresh warm air is passed up from the crypt, and escapes by the upper openings at the top of the dome. The warming is so perfectly effected, that during the first trials, although the heat of the nave was run up to a considerable extent above the mean point, the increase was not more at the roof on the average than at the floor of the nave. Generally the increase was the same, and on no occasion

was it more at the roof than two degrees above the floor. This effect is obtained entirely by the peculiar nature of the stove and the convection of heat caused thereby. The stove patented by Mr. Gurney carries out in a simplified form the principles of the apparatus which for five years has been used in warming the Houses of Parliament. It consists of a plain interior cylinder, and a series of perpendicular radiating wings. The stove is placed in a pan of water, the water being regulated in depth to produce any required amount of evaporation. The vapour passes, in conjunction with an ascending column of air, over the external surface of the stove, rising up between the wings, and by this means prevents the stove from being over-heated, and the air from being over-dried or burnt. The main cause of its success is the evaporation of water from the pan in which the stove stands. This evaporation is caused entirely by conduction from the lower part of the wings of the stove, which dip into the water in the pan, the evaporation being so regulated that it shall be in exact ratio with the heat given off by the stove. By this means the proper break of the hygrometer is maintained under all circumstances, and a healthy state of the atmosphere warmed by it secured. And not only is the break maintained, but the evaporating process has the advantage of causing a great abstraction of heat from the stove, consequent upon the contact of vapour with the metal, and the rapid current of air induced by the wings of the stove. This again gives a healthy circulation, and, with the convection, causes the heat to be carried into every portion of the building in which the stove is placed, even in the extreme case of its position being at one end of an oblong room. It is also evident that the rapid abstraction of heat effectually prevents the overheating of the stove, and the consequent burning of the air.—*Abridged from the Mechanics' Magazine,* No. 1839.

GERNER'S PATENT APPARATUS FOR PRODUCING GAS FROM OILS, &C.

MR. H. GERNER, C.E., of Bayswater, has patented an invention which consists in the construction and adaptation of the retort used in producing Gas from Oils, or from fatty or resinous matters, so as to regulate and economize the heat, increase the production of the gas, and afford facilities for cleansing and repairing. The patentee constructs the retort of a cylindrical or other form, and through the centre, from the base upwards, forms a flue or chimney. At the sides of the retort he arranges pipes (he prefers three), which form flues leading from the outside of the retort, through it, and into the central flue. The top of the retort is made of a separate piece, and fits securely by means of a joint of lead or other fusible metal. The retort is erected upon bricks or fire-clay, so as to have a space between it and the clay or brick-work. The fire is placed at the base of the retort, and by means of a damper he causes the heat to pass either up the central flue, or the sides, and through the pipes, *or both ways.* The oil or fatty or resinous matter is supplied *through feed tubes (say three),* arranged with syphons and funnels,

and made secure through the top of the retort, with their outlet orifices near the internal base of the retort, and near the central flue. In the interior of the retort he arranges a grate above the orifices of the feed tubes, and upon this grate and around the central flue and pipe flues and feed tubes places some material capable of sustaining a red heat. He prefers to use scrap iron, or earthenware, or cokes, or a mixture of these. The gas or vapour of the oil arising from the heated base of the retort, will pass through the grate and the said materials, and be thus rendered more subtile ; and from thence the gas is passed, in the ordinary manner, through a pipe from the top of the retort into the condenser, and subsequently into the gasometer. He also arranges or casts with the outside of the retorts two pipes or passages, which protrude through the brick-work or outside of the stove, and are fitted with "man-hole" lids or covers, which may be removed at any time it is desired to clean or repair the interior of the retort. For details, see the *Mechanics' Magazine*, No. 1841.

IMPROVEMENT IN GAS LIGHTING.

A NEW Burner has been recently invented by Mr. Clark, of the Metropolitan Light Company, West Strand, with a view to provide a more perfect and consequently a more economical means for developing the illuminating properties of Gas. It differs from the common Argand burner only in the manner in which the oxygen is supplied and regulated. By means of external and internal glass cylinders, a regular current of atmospheric air is maintained—externally, immediately above the point of combustion, and internally somewhat below it—the result of which combined action is an exceedingly clear and white light, of great brilliancy, remarkably free from smoke and heat, and according to the size of the burner, of great volume. The object of the inventor, in designing this improvement, was to substitute gas for oil as the illuminating power for our coast light-houses, for which, when facilities for obtaining or manufacturing gas exist, it appears admirably adapted ; and according to his statement, the effect of such substitution, if introduced in conjunction with his plan of concentrating a large body of light in one flame, instead of using a number of small burners, as in the present mode of illuminating signal lights, would be a saving of one-half the cost, with a twenty-fold increase in the amount of light. He proposes to apply one of these "Patent Gem Burners" in a revolving silvered glass reflector of three feet in diameter in the place of every ten of the oil lights and silvered metal reflectors now in use ; and in those lighthouses where Fresnel's system is adopted, he proposes to introduce a silvered sphere of six feet diameter, to be illumined with small reflectors and burners.

WARNING TO GAS CONSUMERS.

THERE is a prejudice against gaslight as being the most injurious form of artificial illumination. There can be little doubt that, from its abuse and bad management, it is really doing more mischief than

any other kind of light; its very excellences are turned to bad account; its extreme cheapness, compared with other sources of illumination, naturally leads to its use in excessive quantities; floods of light are poured forth, so that persons may read and sew for hours together in the remotest corners of the room. The air is heated by the excessive combustion, and poisoned by large quantities of carbonic acid, which there are no means of removing. In cold weather, shopkeepers shut their doors, so that the gas may warm the place—this, however, is a most dangerous and unhealthy practice, as dangerous as a charcoal stove. Where you burn gas, take care to have plenty of ventilation.—*New York Paper.*

PATENT GAS REGULATOR.

MR. HERBERT W. HART, of Birmingham, gas engineer, has introduced a method of regulating the pressure of Gas in its transmission to gas burners, by the introduction of a Regulator in the main pipes through which the gas passes, whereby a steady and nearly uniform pressure is maintained at the burners, whatever may be the pressure from the source of supply. This regulator consists of a chamber filled with a fibrous material, so that the gas in its passage must pass through or amongst the fibres. In preparing this permeable fibrous body, the patentee takes layers of felt or other fibrous material, and makes up a sufficient thickness according to the initial pressure of gas, the fibres being disposed transversely to the passage of the gas, and held together by perforated or other porous plates. By means of suitable connexions between these porous plates, he causes the fibres to be compressed more or less, according to the density of the body required, which will also be according to the initial pressure of the gas. The fibrous material being held somewhat loosely together, the pressure of the gas produces this effect. The greater the initial pressure becomes, the more the fibres are compressed together, rendering it more difficult for the gas to permeate. Thus, by the self-action of the gas on the regulator, the exit pressure is regulated and rendered uniform. In order to intercept the grosser impurities of the gas before passing through the regulator, a little loose wool is placed between the ingress passage and the body of fibrous material before mentioned, which latter also has a similar effect in filtering and purifying the gas.—*Mechanics' Magazine,* No. 1830.

COOPER'S PATENT SAFETY LAMPS.

MR. G. COOPER, of Sheffield, has patented an improved Safety Lamp, in which he combines a modification of the "Argand burner" and the "Davy lamp." The base of the lamp contains an oil chamber surrounded by a concentric ring and air passage communicating with the centre. The air is drawn from within a wire gauze enclosing the lamp to afford a supply of oxygen to the interior of the flame. The wick is fixed in a tube of such diameter as may be found suitable, *and can be regulated* at pleasure by turning the body of *the lamp. Combustion is* promoted by a glass chimney which sur-

rounds the flame, and communicates with a gauze division at the top, and thus prevents to a great extent the mixture of the vitiated gas resulting from combustion with the air required to support combustion. It also effectually prevents the gauze surrounding the light-yielding portion of the lamp from being clogged up or darkened by smoke, oil, or other impurities. Two additional thicknesses of gauze are introduced at the top, to prevent all risk of the ignition of the gas outside the lamp. The lamp can be locked so that the person using it cannot under any circumstances without the key have access to the light.—*Mechanics' Magazine*, No. 1808.

KIMMERIDGE COAL.

THE mines of bituminous shale lately put in operation on the coast of Kimmeridge, Dorsetshire, are being worked with great success. So manifold are the applications of this coal, that besides producing the finest candles yet known, and yielding a gas of great illuminating power, experiments and analyses show that it is most valuable as a manure. On distillation it yields a variety of oils, and by a certain simple process the residue can be manufactured into an hydraulic cement. The property is leased to Messrs. Wanostrocht and Co.

GASLIGHTS IN A COAL-PIT.

IT is well known that one of the greatest difficulties coal-miners have to contend with in the prosecution of their arduous labours in the bowels of the earth is a deficiency of light, the artificial means of illumination afforded by the Davy lamp being very inadequate to the requirements of the men in the thick darkness of a coal-pit. It has recently been found safe and practicable, under proper precautions, to introduce Gas Lights in Coal Mines, thereby vastly facilitating the operations of the colliers. This valuable improvement has now been adopted at the High Elsecar Colliery, near Barnsley, the property of Earl Fitzwilliam, and naked gaslights are now burning in all the board gates and stables. After the experiment thus made has been fairly tried and found successful, gas will be introduced into every part of the workings, and, where absolutely necessary, through the medium of the Davy lamp.

LIGHTING A VILLAGE WITH PEAT GAS.

THIS has been accomplished by means of gas made from bogs in Ireland, under Mr. R. L. Johnson's patent. In 1857, Mr. John Wilson, J.P., Daramona, Westmeath, had gas-works erected at his private residence to light up that building, the out-offices, farm-yards, &c. Since that time he has used no other kind of artificial light than that made from the turf of his locality, considering it brilliant, economical, and in every way suited to supply the wants of a gentleman's residence. Mr. Wilson next arranged with Mr. Johnson for the erection of a second and far more extensive apparatus, in order to light with turf-gas a village on his property. Upon the first night of lighting, arrangements were completed at about half-past eight P.M., and word given to "turn on" the gas;

when, a light having been handed to the proprietor, he applied it to one of the ornamental gas fittings which had been placed in that building, and there issued forth a gas of pure brilliancy.

HARDENING ENGRAVED COPPER PLATES.

MR. F. JOUBERT has read to the Society of Arts, a paper "On a Method of rendering Engraved Copper Plates capable of producing a greatly increased number of Impressions." The last century, he said, produced many engravers of great merit, and in this country, foremost amongst them were Hogarth, Sir Robert Strange, and James Heath. The excellence of their works gave rise to such a demand for print impressions of their engravings, that some forty years ago, when it was found that a copper plate could not yield a sufficient number of impressions for the demand, steel plates were introduced. It became, however, a desideratum to harden the surface of the copper plate, and protect it from wear while printing.

It appears that, in March last, M. Jacquin, of Paris, took out in this country a patent for a method of coating plates with iron, which had already been successfully applied in France, and of which the merit is due to M. Henry Garnier, of Paris, with whom M. Joubert had had the advantage of co-operating in the development of the invention. The principle is this:—

If the two wires of a galvanic battery be plunged separately into a solution of iron, having ammonia for its basis, the wire of its positive pole is immediately acted upon, while that of the negative pole receives a deposit of the metal of the solution. This is the principle of the process, which has been named "acierage."

The operation takes place in this way: By placing at the positive pole a plate or sheet of iron, and immersing it in a proper iron solution, the metal will be dissolved under the action of the battery, and will form an hydrochlorate of iron, which, being combined with the hydrochlorate of ammonia of the solution, will become a bichloride of ammonia and iron; on a copper-plate being placed at the opposite pole and likewise immersed, if the solution be properly saturated, a deposit of iron, bright and perfectly smooth, is thrown upon the copper-plate.

It is important that a ferric solution should be employed which will not dissolve or corrode the plate intended to be coated, for if it be attempted to use such a solution, though the iron will be precipitated, it will not only be in a non-coherent state, but the engraved surface itself will be liable to be attacked and injured. It was further shown that the coating of iron admits of being removed from a printing surface of copper without injury to the original plate: hence the original plate may, after being coated and used for some time, have the worn coating removed, and then be re-covered with an iron coating as often as may be required. The inventor mentioned that electrotype plates could not be employed because of their softness; but in future, by the application of the invention, it would only be necessary to multiply electro casts to such an extent as might be necessary to ensure the production of prints or impres-

sions with the requisite speed. At the same time, an original engraving on copper would become, when treated according to the invention, more lasting than if engraved on steel; and by this means, it is stated, 12,000 impressions have been produced from one copper-plate.—*Builder*, No. 825.

The *Art-Journal* has the following judicious remarks upon this invention: "We have had an opportunity of examining certain of the plates faced with steel, as well some that have been worked, as others that were prepared for working. The substance of the discovery is the coating of the engraved copper-plate by means of the electrotype process; but the most extraordinary feature of the result is the perfect equality of the disposition of the steel surface, which is so true and even that no single line of the engraving is changed; in short, a proof from the copper cannot be distinguished from a proof from the surface prepared with the electrotyped surface. On occasions, as for Art-Union prints, when a great number of impressions are required, it has been customary to electrotype the plate to the extent of eight or ten fac-similes; but sometimes an electrotype plate will fail after yielding two hundred and fifty impressions. But the plates prepared according to the patent in question will throw off many thousands of impressions without any apparent wear of the surface of the plate. And should such a number of prints be required as may wear out the surface, which results rather from wiping than its contact with the paper, then the worn coating of iron or steel (for the metal partakes more of the character of the latter than of the former) may be dissolved off from the plate, and a fresh coating of iron deposited thereon; after which, the printing may be resumed as before, and by thus, from time to time, renewing the coating of iron, almost any number of impressions may be taken from the engraved plate."

MUSIC PRINTING.

A PATENT has been obtained by Mr. Scheurmann, the music publisher in Newgate-street, for a new method of Printing Music, invented by him.

It is well known that the present comparative cheapness of musical publications has been caused by the adoption of type-printing as the substitute for engraving. By this means, editions of standard works of large circulation, such as Handel's Oratorios, &c., are now sold at prices which a few years ago would have been incredible. But Mr. Scheurmann's invention will carry this advantage much farther, and will be much more generally applicable. Even in the best of the present cheap publications (such as those of the Oratorios used at Exeter Hall) the immense number of separate pieces of type—in some instances between three and four thousand being employed in setting up a single page—causes a waste of time and labour, and also gives the printing a disjointed and broken appearance. These objections are obviated by Mr. Scheurmann's mode of setting up the lines and the notes on two separate plates, the whole

of one stave forming a single piece of metal, and the notes also being solid. The result, independently of the great diminution of labour, is a clearness and sharpness of appearance quite unattainable by the old process—a fact shown by the specimens which we have examined. The lines and notes being thus separately set up, in order to avoid the necessity of double printing a cast is taken of the notes, and into the mould thus obtained, the frame containing the lines is pressed. A matrix combining the two plates is thus formed, which is then placed in a galvanic trough, where it receives a thin shell of copper of a few ounces weight, obtained by the electrotype process; and the plate, being backed with lead, is ready for printing.

There are many ingenious contrivances in the working out of Mr. Scheurmann's plan. Among other advantages, it is evident that, on an average, only one-tenth of the number of types at present in use will be required by the new method; and that of course there must follow a proportionate diminution in the cost of production, and a corresponding reduction in the present price of music. By this process, too, the music may be transposed to any key by simply altering the signature (the sharps or flats at the beginning of the piece), and raising or depressing the frame containing the lines, without the necessity of resetting a single note. Another striking consideration is the facility with which a plate of music once formed in the manner we have described, may be multiplied by the simple expedient of taking casts from it. From this, the most important results must naturally arise.—*Daily News.*

IMPROVEMENTS IN PRINTING MACHINERY.

MR. APPLEGATH, whose name is universally known in connexion with Printing Machinery, has introduced and patented a set of Improvements which are applicable to machines where the type or printing surfaces are fixed on a cylinder, and where the paper is fed into the machines in the form of sheets. Heretofore, in such classes of machines, the printing rollers have been of larger circumference than the length of the sheets of paper to be printed thereby, by which arrangement comparatively few printing rollers can be ranged round the cylinder carrying the type of printing surfaces. Mr. Applegath's improvements consist in reducing the size of the printing cylinders so that they may be less in circumference than the length of the sheets of paper to be printed, and sometimes two or more feeding apparatuses are applied to each printing cylinder. In this way the number of printing cylinders working with a given diameter of cylinder, and consequently the number of impressions obtained from each revolution of the type cylinder, may be increased. It is preferred that each of the printing rollers or cylinders should be wholly covered with blanket or felt when working with such descriptions of printing machines. In some cases the patentee applies a small roller or rollers with type or printing surfaces thereon, together with proper inking apparatus to each of the printing rollers or cylinders. In this way he is enabled, while printing the main

portion of the sheet by the large type or printing cylinder as heretofore, to introduce, for instance, a heading in a different colour, or, in fact, any matter which it is desirable to introduce; and this introduced matter may be changed without interfering with the form on the large printing cylinder.

NEOGRAPHY, A NEW METHOD OF PRINTING.

A curious description of a new method of printing, invented by a journeyman printer named Chevallier, and called by him Neography, has been given to the members of the Cercle de la Presse Scientifique. The object the inventor had in view was to obtain printing surfaces of a better quality than stone, zinc, or any other substance hitherto used; and moreover to get impressions of different colours by a single operation, instead of bringing the sheet under the press several times. The *modus operandi* is as follows:—The figures or characters to be produced are drawn upon a woven stuff or any other which may be penetrated by a liquid; the ink used for the purpose is composed of lamp-black, Indian ink, gum, sugar, and common salt. This done, the side on which the figures have been drawn receives a slight coating of gutta-percha, and when this is dry the surface is washed. Now, since the ink is composed of soluble matter, this will wash off, and the gutta-percha which covered the characters, and which therefore does not adhere to the stuff, washes off too, by which means the stuff becomes a surface which is only penetrable by liquids in those places where the characters were drawn, and is perfectly impenetrable everywhere else. This done, the wrong side of the stuff receives the ink and colours which are to serve for printing, while the sheet is laid on the right side. Under the action of the press, the ink and colours penetrate through the unprotected places, and a clear impression is obtained. Instead of applying the ink and colours as stated, a permanent kind of cushion, made much like the balls formerly used for inking type, and properly charged with ink or colours, may be placed under the stuff, and thus many sheets may be worked off, before it is necessary to renew the ink. This invention has cost M. Chevallier six years of labour and trouble to render it practically useful.—*Critic.*

PATENT PRINTING TYPE.

The Patent Type-founding Company have patented these two important improvements in the manufacture of Type.

The first patent has for its object the production of type of greatly increased hardness and durability. This is effected by the use of a new alloy.

The object of the second is to reduce the cost of production by employing peculiar machinery instead of the usual tedious process of hand-casting.

Previous to the date of the first patent, the old alloy of lead and antimony was alone used. This is but slightly harder than lead, yields readily under the press, and becomes rapidly deteriorated. Attempts to produce a better article had failed, and had led to the

confirmed opinion that hardness could not be obtained without corresponding brittleness. The inventor (Mr. Johnson) of the patented inventions in question overcomes this difficulty; and, having specified the mode of effecting it, numerous imitators have arisen, all of whom, it is alleged, produce type which is inferior to that of the original inventor.

The subject of the second patent is an ingenious mechanism for casting type by the simple revolution of cams. An iron vessel is charged with the metal, kept in a state of fusion by jets of gas. In this vessel a small pump is placed. A mould and matrix are fitted in front of the pump, and are moved by cones. When the mould is properly adjusted, a cam causes the pump to inject a measured portion of liquid metal into the mould, and this instantly becomes cool and solid by the conduction of the metal of which the mould is formed. The type so formed is then thrust out of the mould, which again closes for the reception of another dose of metal.

About twenty patents were taken out for machines before the date of that we are describing, but it is said that all these failed to produce perfect type. It is certain that the chief founders in London have not adopted them in practice, notwithstanding that machines have been purchased by their proprietors. All the twenty machines alluded to, with one exception, use the ordinary hand-mould as the starting point, the mechanism merely imitating the motions of the workman. The failures are entirely attributable to the fact that to cast perfect type with the hand-mould, intelligence, as well as mere muscular motion, is required, and this can never be supplied by mechanical means. The workman ascertains by the sense of touch whether this mould is in perfect order, and, if not, the operation of casting is arrested, the mould cleaned, &c.; otherwise he produces "big bodies," which again would cause irregularities in the "line." But no machine can exercise this discrimination, and hence the imperfect result. Mr. Johnson's patent overcomes this difficulty by discarding the old moulds, and substituting one in which the body is formed by an aperture of fixed dimensions instead of one made by two moveable parts. Any particle of metal remaining from the preceding operation is merely united to the next jet of metal, without affecting the dimensions of the type cast; whereas such particles interposed between the moveable surfaces of the old mould would have prevented their contact, and enlarged the orifice, and thereby caused a type to be formed with a "big body." Other ingenious arrangements correct the tendency to irregularity of "line," tearing of the faces, &c., with which other machines are reproached.

This machine obtained a first-class medal at the French Exposition, and a Committee of the Paris Chamber of Printers officially reported that "it yielded invariable and correct results, and was the most perfect and simple machine that had appeared." It has been adopted by the Imperial offices of Paris and Vienna, and was employed to produce the type used for printing that huge volume, the "*Jury Reports.*"—*Mechanics' Magazine*, No. 1818.

Natural Philosophy.

THE ROYAL SOCIETY.

At the Anniversary Meeting, November 30, Lord Wrottesley, as President of the Royal Society, delivered his farewell address to that body.

Lord Wrottesley commenced by congratulating the Fellows, that all the measures rendered necessary by the removal of the Society to Burlington House had been completed; and that they now met in an apartment, which, by its size and decorations, may be said to be truly worthy of a Society, which, for nearly two hundred years, has taken the lead in fostering a spirit of investigation into the laws of Nature, and thus promoting the best interests of its country and mankind. "I rejoice," said his Lordship, "that our walls are once more adorned by some of the pictures of the most eminent of the many distinguished men who, by their lives and discoveries, have left an imperishable name to posterity, and shed a halo of glory over the whole human race. Even as amidst the ruins of Iona, our great moralist felt his religious enthusiasm powerfully aroused, so may the sight of these portraits kindle in us and our successors an earnest desire to emulate the virtues of those whom they represent—that spirit of persevering research which achieved such brilliant success—that regard for truth which deems no sacrifice too great when the interests of truth are at stake—that modesty, the never-failing companion of genius, which slightly regarding the results attained, is almost overpowered by the sense of what remains to be accomplished."

In a former address, hopes were expressed that the Government would send an Expedition to the mouth of the Mackenzie River, to continue those magnetical observations which had been so perseveringly and successfully carried out by Capt. Macguire, and from which Expedition important accessions to magnetism would result. Unhappily these hopes have not been realized. The disappointment may possibly be traced to the dislike entertained to anything which can by possibility be designated as a renewal of Arctic voyages, and to a want of a due appreciation of the value of the proposed researches; for it is impossible to believe that any one of average capacity and discernment would undervalue the importance of prosecuting researches of this character, were he familiarly acquainted with the history of scientific discovery. "If," said Lord Wrottesley, "our leading statesmen and legislators had perused with the same attention the records of the progress of science, as many of them have devoted to the historical memorials of the two great nations of antiquity, can it be doubted that they would view the questions in a far different light?"

The laying of the Atlantic Telegraph was next adverted to, and a sketch was given of some of the countless researches which preceded the invention of this wonderful means of communicating with

distant nations. In 1729, Grey discovered that electricity could be transmitted to a distance. In 1747, it was sent through several miles of wire. In 1753, an anonymous writer in the *Scots' Magazine* first suggested the idea of an electric telegraph. In 1800, the voltaic battery was invented. In 1802, it was discovered that the earth might be substituted for the return wire of a voltaic circuit. In 1820, Oersted discovered the mutual action of voltaic conductors of magnets, the foundation of the science of electro-magnetism. In 1822, Ampère developed the laws of electro-magnetism, and discovered many new facts, and Arago detected the action of a voltaic current on soft iron. In 1827, Ohne developed the laws of the voltaic circuit. In 1832, began the brilliant researches of Faraday, in which he discovered and enunciated the laws of voltaic and magneto-electric induction. In 1834, Wheatstone invented and practically applied a method of measuring the velocity of electricity in metallic wires. In 1835, Gauss and Weber established a system of electric telegraphic communication between the Observatory at Göttingen and the University; and in July, 1837, Wheatstone first tried his telegraph on the line of the London and Birmingham Railway. During all this time the voltaic battery was gradually improved, and its powers vastly augmented, by Daniell and Grove.

Chemistry was also brought forward, as affording abundant evidence of the advantages derived from the pursuit of abstract science, when viewed in its bearing upon the comfort and convenience of mankind.

At the close of the last century, the Swedish chemist Scheele made a series of experiments on the black oxide of manganese. To some this might have seemed a very unprofitable waste of time; but what was the result? Chlorine was discovered, a substance of the greatest importance in the arts. Berthollet, finding that this gas changed the colour of the corks of the bottles in which it was confined, suggested its employment as a bleaching agent. This led to a total revolution in the art of bleaching, shortening the process from several months to a few hours. Again, the discovery of iodine was the result of a not very promising examination of the refuse of kelp liquors, and a laborious train of investigation into the laws of decomposition gave us chloroform, which, besides greatly alleviating human suffering, is the basis of Photography. Then, again, Professor Owen has lately shown how much agricultural wealth may be derived from the proper application of a single neglected fossil.

There is now every reason to hope that the Government of Victoria will erect a four-foot reflector for the observation of the southern nebulæ; and thus what has been done, and is now doing, for the nebulæ in our own latitudes by the magnificent instrument of Lord Rosse, will be imitated at Melbourne. The history of the progress of astronomical science has already disclosed both the evil effects of neglecting these duties, and the benefits which are likely to accrue when they are properly fulfilled. Thus the motions of the comet of Encke *first suggested* to astronomers the probability of the *existence of some highly* attenuated medium or ether pervading the

planetary spaces, in which both planets and comets perform their revolutions. Every succeeding return of this most interesting though diminutive body has tended to confirm and strengthen that probability, which has now nearly, if not entirely, assumed a physical fact; and if this be conclusively established, it will be of the utmost physical importance. Mr. Maclear's fine equatorial, which has been of signal service in observing Encke's comet at the Cape of Good Hope, will now be turned to profitable account in following up the fine comet of Donati, which has just escaped from our view to present itself, but shorn of most of its former splendour, to the expectant gaze of Southern astronomers.

Lord Wrottesley next proceeded to give an account of the steps taken by the Council of the Royal Society and the Committee of the British Association relative to the re-establishment for a limited period of magnetical observations at the four stations of Newfoundland, Vancouver's Island, the Falkland Isles, and at Pekin. The Government has been strongly urged to grant a sufficient sum of money for this purpose; for besides the benefits which may flow from the complete elimination and elucidation of the magnetical laws, the construction of correct and complete charts, showing the variation and the isodynamical and isoclinal lines at some given epoch, is alone an object of transcendent importance to commerce and navigation. To this must be added the accurate establishment of the data on which are founded the methods adopted for ascertaining and correcting the deviations of the compass in iron ships; and in addition to all this, we must always bear in mind that the result of modern speculations seems to show that all the so-called imponderable agents—heat, light, electricity, and magnetism—are intimately connected by mysterious links; every accession to our knowledge of one has therefore an important bearing on the elucidation of all the others.

The Patent Laws were then adverted to, and Lord Wrottesley stated that the whole subject of their working must at no very distant date undergo a searching investigation. It can never be tolerated that inventors to whom we owe inestimable accessions to the conveniences and business of life should be subject to a tax peculiar to their class alone; and this must be the effect of the present law so long as fees are received from the patentees, exceeding the amount which may be reasonably demanded for purposes in which they have themselves a direct interest, and the surplus carried to the account of the public exchequer.

A contrast was then drawn between the system adopted by our Government in obtaining scientific counsel with that of Continental Governments.

In conclusion, Lord Wrottesley adverted to the blot in our system, that men eminent in the various walks of science are not officially recognised, in any way, as authorities, or appealed to, *except* occasionally, and by accident, whenever some member of the *Administration* may happen to perceive that their counsel might *advance the object* in view, and be profitable to the State; it seem-

ing never to have occurred either to the Government or Parliament that the materials exist out of which a Board may be formed, which might be expected to give wholesome advice on scientific questions,—take on themselves a share of the Government responsibility, and save the country from the bad consequences which now flow, either from neglecting to take counsel, or from the careless and indeterminate way in which it is sometimes sought and obtained. Lord Wrottesley is willing, however, to admit that these evils are mitigated by Parliament placing the sum of 1000*l.* yearly, in aid of scientific researches, at the disposal of a Board appointed by the Council of the Royal Society.*

Lord Wrottesley then took a graceful farewell of the Society; and in resigning the chair, paid a well-merited tribute to the distinguished *savant* (Sir Benjamin Brodie) by whom his Lordship has been succeeded. (*See the Frontispiece to the present volume.*)

The following medals were then awarded:—The Copley medal to Sir C. Lyell, for his various Researches and Writings, by which he has contributed to the advance of Geology; a Royal medal to Mr. A. Hancock, for his various Researches on the Anatomy of the Mollusca; a second Royal medal to Mr. W. Lassell, for his various Astronomical Discoveries and Researches; and the Rumford medal to M. Jules Janin, Professor in the École Polytechnique, Paris, for his various Experimental Researches on Light.

The Society then proceeded to the election of Council and officers for the ensuing year, and the following noblemen and gentlemen were duly elected:—*President,* Sir B. C. Brodie, Bart.; *Treasurer,* Major-Gen. E. Sabine; *Secretaries,* W. Sharpey, M.D., and G. G. Stokes, Esq.; *Foreign Secretary,* W. H. Miller, Esq.; *Other Members of the Council,* H. W. D. Ackland, M.D.; Admiral Sir G. Back; Rev. J. Barlow; T. Bell, Esq.; the Duke of Devonshire; E. Frankland, Ph. D.; J. P. Gassiot, Esq.; P. Hardwick, Esq., R.A.; A. Henfrey, Esq.; Lieut.-Col. H. James, R.E.; Sir R. I. Murchison; J. Percy, M.D.; A. Smith, Esq.; C. Wheatstone, Esq.; Rev. W. Whewell, D.D.; and the Lord Wrottesley.

The Society and their friends dined after the election at Willis's Rooms—Sir Benjamin Brodie, Bart., in the chair.

DECIMALS.

A DEPUTATION to the Chancellor of the Exchequer, and a public meeting at Liverpool, have called attention to one little phase of the Decimal question. The object is to enact that corn and dry goods should be sold, not by measure, but by the weight of 100 pounds; and that the Customs duties should be taken on 100 pounds instead of the *hundred-weight* of 112 pounds. In many parts of the country some progress has been made: corn, potatoes, &c., *are* sold by weight, though the weights are *called* bushels or pecks. It was represented to the Chancellor of the Exchequer by Mr. Miller, of the Bank of England, that the 112 pounds, instead of 100, causes five

* *This glance at the leading features* of the Address is abridged from the able *Report in the Athenæum, No. 1623.*

millions of useless figures to be written every year, in nothing but invoices, &c., of *bonded tea:* and many of these figures are results of useless calculation. If this be true,—and Mr. Miller is not an easy man to be put down on such a point,—what can be the whole number of figures written down in a year, which might be saved by a complete decimal system of weights, measures, and coinage? Such a calculation serves to give some idea of what the whole number of figures may be which are written down every year in Great Britain. At first, we thought that business might perhaps be represented by two millions of persons writing each one hundred figures a day for three hundred days. But this we had to give up: we could never imagine the useless figures connected with nothing but tea in the Custom-houses to be so much as one out of every twelve thousand of all the numbers written. Consequently, sixty thousand million is not nearly enough: two hundred thousand million is nearer the mark. Nor indeed is it unlikely that every soul in the country, man, woman, and child, should write, one with another, twenty figures a day each. Whatever the number may be, we are satisfied that one-quarter of them are useless and worse than useless consequences of our non-decimal systems. Fifty thousand millions of useless figures, at least, in every year, in the United Kingdom only! and a *million* represents the number of beats of the clock in about twelve days and nights.—*The Athenæum.*

MODE OF CONSTRUCTING THE RECTANGULAR HYPERBOLA BY POINTS.

MR. G. THURNELL has communicated to the British Association a paper on this subject, illustrated by two figures. In the first, Mr. Thurnell showed a very ingenious and simple mathematical construction: by means of concentric circles and parallel lines, he affixed any number of points that might be desired of a Rectangular Hyperbola. In the second figure, he showed the application of this to the forming the model by which to work the shafts of columns with hyperbolical entasis, exemplifying his subject by giving the leading measurements of the columns of the Parthenon.

The President observed, that this was a very simple and ingenious method of constructing the hyperbola by points, and might therefore be useful to architects; but although the Greeks were fully aware of the properties of this curve, and may therefore have constructed the shafts of their columns by it, yet he much doubted whether, after crumbling for ages, the columns of the Parthenon could now give us the infinitesimal distinction between hyperbolic and any other curve they may have used.

MAGNETIC DECLINATION.

FROM a table published by Encke, in the Memoirs of the Berlin Academy, it appears that in the fifteen years between 1839 and 1854 the magnetic "declination," or the westerly deviation of the magnetic *north from the true* north, has diminished 1° 49½'; the "variation" *has, therefore, been* at the mean rate of 7⅓ minutes per annum; but

it has been a little greater in the second half of the term than the first. The declination at Berlin in 1854 was 14° 56′ 52″.—Mr. Maclaren, in the *Scotsman.*

At a meeting of the Royal Belgian Academy, a letter has been read from Hansteen to the secretary, M. Quetelet, stating that with one of Gambey's needles, aided by careful manipulation, he is able to take the precise dip within at least half a minute. From observations made in four summer months with a dipping-needle and unifilar and bifilar horizontal needles, he has come to the conclusion that the diurnal variation, observable in magnetic phenomena, is produced by *a feeble perturbative force which turns round the horizon from east to west in twenty-four hours.* "When this force proceeds to the south, the horizontal intensity diminishes, the inclination augments, and the declination has its mean value (about ten hours before midday); when it proceeds to the north, the horizontal intensity increases, the inclination diminishes, and the declination assumes its mean value, which takes place about an hour before sunset; when it proceeds towards the west or the east, the respective declination augments or diminishes (one hour after midday, eight hours before midday or midnight)." The inclination or dip, which is now decreasing, will reach its minimum, Hansteen thinks, in Western Europe, in 1878, and has already reached it in Siberia. Its maximum was in 1678, indicating a period of two hundred years.

TERRESTRIAL MAGNETISM.

MR. J. DRUMMOND has communicated to the British Association the two following papers:—1. "On the Intensity of the Terrestrial Magnetic Force." In comparing the observations of the dip with those of the intensity, the author found some anomalous results, of which the following is an example. In the diurnal variation the dip is at a minimum about 8 A.M., at a maximum about 11 A.M., after which it decreases to a minimum again about 2 P.M. Turning now to the intensity, the maximum is found to occur about 8 A.M., and the minimum about 11 A.M., after which it again increases, reaching a maximum in the afternoon. From these facts, then, it would appear that, while the earth exerts a greater attracting power over the needle about 11 A.M. than either before that hour or after it, the intensity of the force by which this is accomplished is then at its minimum. In other words, we are driven to the conclusion, that the earth exerts a greater attracting power by a minimum of force than by a maximum,—a conclusion entirely at variance with all our knowledge of the magnetic force. This anomalous result the author traced to the assumption lying at the foundation of the present theory of the intensity,—viz., that the terrestrial force is exerted in the direction of the dip; and from an analysis of the phenomena of the dip he arrived at the following laws:—1. That the true direction in which the earth's force is exerted is in the radial line of its centre, at least so within certain limits, the earth being a spheroid *and not a sphere.* 2. That the force being at all points *upon the earth's surface* exerted in the radial line of its centre,—and

the vibrations of a horizontal needle being, therefore, at all stations made at right angles to the direction of the force, their number at any two or more stations in similar times, or at different periods in similar times, indicates exactly the ratio of the force at each station and at each period.

2. "On the Development of a Physical Theory of Terrestrial Magnetism." The fundamental principle of this theory was the following. Assuming the prevailing idea regarding the early condition and present state of the globe,—viz., that it has cooled down from a state of fluidity, and now consists of a solid crust inclosing a molten nucleus,—the author assumed also that the sun, moon, and other planetary bodies must exert the same influence upon the inclosed fluid which they exert upon the surface ocean in producing the tides: —that, consequently, a system of internal tides must be occasioned simultaneously with the external tides. Further, accepting the theory of Gauss, that the entire matter of the globe is magnetic, he concluded also that the passage of these internal waves must occasion corresponding changes in the position of the needle; and reasoning from these premises, he arrived at the following conclusions, in regard to the changes in position which the needle ought to undergo. A declination needle at any station resting on the line of the magnetic meridian ought, upon one of the internal waves coming from the eastward, to make an excursion to meet it; as the crest of the wave approaches the station of observation, the needle ought to return with it; and when it comes immediately beneath the point of observation, the needle ought to coincide again with the meridian. As the wave proceeds westward, the needle ought to follow it, making a westerly excursion equal to the easterly; and as the wave passes further west, and its influence over the needle thereby declines, the latter ought slowly to return again to the meridian. Again, an inclination needle ought to begin slowly to dip as the crest of the wave approaches the station of observation, reaching its maximum when the wave is immediately beneath it, and slowly rising again to its former position as the wave passes eastward. And the intensity, as indicated by the oscillating needle, ought to increase as the crest of the wave approaches the station, reaching its maximum when it is immediately beneath it, and decreasing gradually as the wave proceeds to the westward, the maximum of intensity thus coinciding with the maximum of inclination. Comparing the results of observation with the conditions of this theory, the author found them completely to harmonize.—*Athenæum Report.*

CONFIGURATION OF THE EARTH.

THE Rev. J. Dingle has communicated to the British Association, a paper "On the Configuration of the Surface of the Earth." This was a most ingenious though very speculative attempt to trace, from the cooling down of a body so composed as our earth is known to be from a high state of incandescence, how the great mountain ridges were first formed, and then in succession the continents, larger islands and groups of islands in succession, by deposits from currents

such as the author conceived must have been early established in the ocean, which volcanic actions, at first most violent, would chiefly manifest themselves along the parts in the neighbourhood of the mountain ridges.

INTERNAL TEMPERATURE OF THE EARTH.

THERE has been read to the British Association, a paper "On the Distribution of Heat in the Interior of the Earth," by Dr. F. A. Siljeström, of Stockholm.

Professor Hennessy remarked that the views of Dr. Siljeström seemed to state in other words the well-known fact, that a mass of fluid possessing different temperatures in different parts of its interior must be subjected to a process of convection. The result is usually a change of volume in the entire mass of circulating fluid. This change is capable of being observed in ordinary experiments, and may also affect the volume of the fluid matter in the interior of the earth, provided the changes of temperature of the fluid are sufficiently great. But it is clearly proved that the refrigeration of the earth is now so extremely slow, that it is not likely that any considerable changes of volumes arising from this cause could have arisen within recent periods. If such changes have arisen, they must have occurred during remote geological epochs.

ROTATORY MOTION.

PROFESSOR BADEN POWELL has communicated to the Royal Institution, a paper "On Rotatory Stability, and its application to Astronomical Observations on board Ships," observing that the subject of Rotatory Motion, especially when taking place under those combinations which are presented in the gyroscope or free-balanced revolver, had attracted much attention at the present day. The primary mechanical principles have long since been acknowledged in theory, but the practical results have been but little considered; so much so, that while these results excited so much wonder when exhibited in a scientific form, it was forgotten how perfectly similar and equally paradoxical in its nature is the common and familiar result of a top sustained, by the mere act of spinning, in a position from which it directly falls when the rotation ceases. The principle of the "composition of rotation" showed the identity of the results on a small scale with the grand cosmical phenomenon of the precession of the equinoxes; but another application of the same principles remained unknown until pointed out, and actually effected, by the inventions of Professor Piazzi Smyth, namely the use of rotatory apparatus for giving an invariable plane or platform for astronomical instruments used at sea. Two simple first principles in dynamics give the clue to the whole of the application for the fixity of the plane of rotation and the composition of rotatory motion. The first is the tendency of a body in rotation to retain that rotation in the same place when perfectly balanced, irrespective of the motion of external objects; the *second is when* a force is impressed on a body *in rotation it does not show itself* directly, but is compounded with the first

motion, so that the rotation takes an intermediate direction, or the axis shifts its position in space. This being the cause of the motion of the earth's axis, giving rise to the precession of the equinoxes, it is called a precessional motion. Professor Powell thus takes a summary view of the whole subject: "The gyroscope, when its equilibrium is slightly disturbed, demonstrates the precession of equinoxes, explains the boomerang, and sustains itself in the air against gravitation. When its equilibrium is undisturbed, it exhibits to the eye the actual rotation of the earth; and when restricted to one plane, it acts as a magnetic needle without magnetism, or spontaneously rotates in parallelism with the earth. To these remarkable and somewhat paradoxical applications, we have now added another of far higher utility—that it gives perfect stability for the nicest astronomical observations on board a ship pitching and tossing with every wave and gust of wind."

PHYSICAL PROPERTIES OF ICE.

PROFESSOR TYNDALL has read to the Royal Institution a paper on this investigation, which he introduced by some remarks on force in general, and then especial reference was made to the force by which crystalline architecture is accomplished. Some phenomena of crystallization were shown by means of the photo-electric microscope. The manner in which the molecular aggregation was affected when a beam of radiant heat was sent into the interior of a mass of ice was examined. The track of such a beam presented a beautiful appearance,—flattened spheroids were observed, which at certain incidences of the light, shone with more than metallic brilliancy, and around each a liquid flower, consisting invariably of six petals, was formed. The spot at the centre of each flower was proved to be a vacuum; and the formation of the flowers in a piece of ice through which a beam of electric light was transmitted was rendered visible to the audience. The air-and-water cavities, which, in the case of glacier ice, have caused so much discussion, were next examined. It was proved that the water was due to the melting of the ice round the air cavities. The hypothesis propounded by M. Agassiz and the Messrs. Schlagintweit to account for this water, and which has hitherto been universally accepted, is, that the ice permits the radiant heat to pass, the heat warms the air, and it, in its turn, melts the ice. It was proved by the speaker that this view is wholly untenable. One of its consequences would be that a bubble of air would be capable of absorbing in a few minutes a quantity of heat which would raise its temperature upwards of 400,000 degrees, or more than 160 times that of fused cast-iron. The melting of the ice was shown to be a simple consequence of the dynamical theory of heat: molecular motion is transmitted through the solid ice, without prejudice to its solidity, and detaches the particles at the surface of the internal cavity, as the last of a series of elastic balls is detached by a force which has traversed a row of them *without producing* visible separation. The passage of snow into glacier ice was next considered. It was referred to the enormous

pressure of the moist *névé* upon its own mass. That moisture was necessary was shown by moulding ice at 32° into cups; while, when it was rendered perfectly dry by immersion in a bath of solid carbonic acid and ether, the ice, on being crushed, became a powder as white as snow. Crushed glass or quartz could not have been whiter or more opaque.

In a paper read to the Royal Society, "On the Stratification of Vesicular Ice by Pressure," Professor Thomson indicates a mechanical theory as the explanation of the veined structure of glacial ice, especially applicable to account for the stratification of the vesicles observed in ice originally clear, and subjected to differential pressure, by Dr. Tyndall; the formation of the vesicles themselves being anticipated by Professor Thomson's brother's theory, published in the "Proceedings" for May, 1857.

Professor Thomson believes the theory he has given above to contain the true explanation of one remarkable fact observed by Dr. Tyndall in connexion with the beautiful set of phenomena which he discovered to be produced by radiant heat, concentrated on an internal portion of a mass of clear ice by a lens; the fact, namely, that the planes in which the vesicles extend are generally parallel to the sides when the mass of ice operated on is a flat slab; for the solid will yield to the "negative" internal pressure due to the contractility of the melting ice, most easily in the direction perpendicular to the sides. The so-called negative pressure is therefore least, or which is the same thing, the positive pressure is greatest in this direction. Hence the vesicles of melted ice, or of vapour caused by the contraction of melted ice, must, as here shown, tend to place themselves parallel to the sides of the slab.

The divisions of the vesicular layers into leaves like six-petaled flowers, is a phenomenon which does not seem as yet so easily explained; but Professor Thomson cannot see that any of the phenomena described by Dr. Tyndall can be considered as having been proved to be due to ice having mechanical properties of a uniaxal crystal.

ATMOSPHERIC TEMPERATURE AND THE EARTH'S SURFACE.

PROFESSOR HENNESSY has read to the British Association, a paper "On the Heating of the Atmosphere by Contact with the Earth's Surface." The Temperature of the atmosphere depends principally on the heat which it receives from the sun and on what it loses by radiation. A portion of the solar heat is absorbed in passing through the air, while another portion penetrates to the earth's surface. The ground becomes thus heated, and the lower strata of the atmosphere acquire the greater part of their heat from contact with the warmed surface. It is admitted that the mode in which the air becomes heated by contact with the ground must be a kind of circulation analogous to that seen in the movements of a heated mass of liquid, such as boiling water. When studying the vertical movements of the atmosphere, with reference to which Professor Hennessy made a communication to the Association last year, he had been led

to consider the connexion between such movements and the influence of the heated ground. In order to experimentally study the question, thermometers were suspended at different heights above the ground, and under different circumstances of exposure to the influence of the supposed currents. Observations were made every minute, and sometimes every half minute, during short intervals, about the middle of the month of May, on days when the sky was clear, and during which there was consequently a great deal of solar radiation. In general the thermometers exhibited fluctuations of temperature, the intensity of which diminished the more they were protected from the influence of circulating currents in the air. The greatest fluctuations were presented by thermometers with blackened bulbs exposed in the sun. This arose from the circumstance that the blackened bulbs, by acquiring a high temperature, became themselves disturbing agents in the calorific conditions of the surrounding air. Evidence of similar phenomena appears to be presented by the curves of temperature obtained by the aid of photographical registration at the Radcliffe Observatory in Oxford. Attention has been called by Mr. Johnson to a remarkable serration in the temperature curves during the day. This serration is found only when there is a considerable amount of solar radiation, it disappears during sunless and cloudy weather. While it is explained by referring it to the influence of the solar heat upon the ground, and the consequent circulation of small atmospheric currents, it affords a very satisfactory confirmation of the trustworthiness of the photographical method of registration.

Professor Hennessy then read to the Section, a paper "On the Decrease of Temperature over Elevated Ground." He showed that the decrease of temperature in ascending through the atmosphere depended not only on height above the sea level, but also upon the absolute height above the nearest surface of solid land. In this way the decrease of temperature over plains, mountains, and plateaux would be necessarily very different, and we cannot immediately infer the state of the phenomena in the two latter instances from what may exist in the former. Some of the results of observations made on some of the hills and mountains of Ireland during the Ordnance Survey, as contained in the volume recently published by Colonel James, were referred to as illustrations of these general views, upon which, however, considerable discussion ensued in the Section.

OCEANIC TEMPERATURE.

Some interesting information has been given by Captain Pullen, R.N., of H.M.'s ship *Cyclops*, relative to the Temperature of the Atlantic and Indian Oceans at great depths, in his recent voyage to the East. The first sounding for temperature was in 32° 13′ N., long. 19° 15′ W., where, at 400 fathoms, the minimum temperature was 50·5°, the surface at the time being 70°. Subsequently, two thermometers were sent down at 500 and 800 fathoms; at the greater depth the minimum temperature was 44·5°, at the lesser 50°. The next sounding was in lat. 10° 7′ N., long. 27° 32′ W., when there

was no bottom with 2000 fathoms of line. In 4° 16′ N., and 28° 42′ W., two thermometers were sent down to 1500 and 1000 fathoms, the greater depth showing a minimum temperature of 39·4°, the lesser of 42·5°. In the next cast, in lat. 2° 20′ N., long. 28° 44′ W., ninety miles from St. Paul's Island, two thermometers were sent down on a regular deep-sea line, with bottom at about 1080 fathoms; the thermometer showed a minimum temperature of 38·5° at the lowest depth, and 46·2° at 680 fathoms. An attempt to get a cast directly on the Equator was unsuccessful, resulting in the loss of a large portion of the line. After crossing the Equator, thermometers were sent down at nearly every tenth parallel, three at a time, at twelve, eight, and four hundred fathoms; and portions of the water brought up were reserved to be sent home for analysis. In lat. 26° 46′ S., and long. 23° 52′ W., soundings were obtained at 2700 fathoms. A thermometer sent down to this depth came in showing a minimum temperature of 35° F.: the bottom brought up in the valve was a very fine brown-coloured sand. Running the casting down between the parallels 35° and 38° S., to outside the Mauritius, the lead was brought into play on the Brunswick shoal, which is marked 85 fathoms, but bottom was not reached with 1410 fathoms. Then came the Atalanta, marked as an extensive shoal; here a cast was obtained with bottom at 1120 fathoms. The bottom consisted of what appeared to be very fine sand covering a hard substance, supposed at first to be coral, but which, under the microscope, was found to be some very beautiful specimens of Diatomaceæ. Steering now to pass to the east of Mauritius, a little south of parallel 20°, about ninety miles from land, there was no bottom with 1375 fathoms of line. Captain Pullen states that this gave him the first idea that his previous opinion of the Indian Ocean not being so deep as the Atlantic was wrong. Forty or fifty miles west of the northern part of Cargados 1400 fathoms of line reached the bottom; at the doubtful St. George's Island bottom was not reached with 2000 fathoms of line. Steaming then for Rose Galley Rocks, bottom was obtained with 2254 fathoms of line: the minimum temperature was 35°. A thermometer was sent down at 2000 fathoms, and returned with a minimum temperature of 38·5°. Now 35° was the minimum temperature at 2700 fathoms in the Atlantic, further south than this cast. Captain Pullen was therefore inclined to think that this is the minimum temperature of the great depths of the ocean, and that it commences soon after passing 2000 fathoms.—*Critic Report.*

LUNAR INFLUENCE ON THE TEMPERATURE.

MR. J. P. HARRISON has communicated to the British Association, "Further Evidence"* upon this question.

The author in resuming the subject first recapitulated some points connected with it, which he considered had been almost established as meteorological facts: viz., 1. that the temperature before the first quarter is lower than that of the second day after it. 2. That this fall and rise prevail most in the winter months

* *For the previous results, see Year-Book of Facts*, 1858, p. 136.

and in the month of May. 3. That a reciprocity of action takes place between corresponding days of the moon's age. Thus, whilst it was found, both at Dublin and Greenwich, that for twenty-one consecutive years the mean temperature rose at the first quarter in more instances than it fell, it fell at the last quarter in more instances than it rose; and in the only two years in which a fall occurred instead of a rise at the first quarter, there was a rise instead of a fall at the last quarter. Between new and full moon, this reciprocity of action was still more apparent. Here, for the same series of years, there was a fall in thirteen years after new moon, and a rise in thirteen years after full moon; and in five out of the eight instances in which a rise occurred instead of a fall at new moon, a fall instead of a rise took place at full moon. Also a like principle appeared to hold good in individual months. For example, in twenty-one consecutive Januarys, a fall occurred in seventeen at new moon, while a rise took place in sixteen at full moon. The action thus apparent at different periods of the lunation was shown clearly in curves of temperature of each day of the moon's age.

A curve of ten years' mean temperature at Greenwich, for 1837—1846, was exhibited in juxtaposition with one sent to Dublin last autumn, which was also formed of ten years' mean temperature, at the latter station, for 1847—1856. At first and last quarters the curves corresponded in a most remarkable manner at both stations. At new and full moon they alternated; the fall in the Dublin curve being at new moon and the rise at full moon; in the Greenwich curve, the rise at new moon and the fall at full moon. Leaving the consideration of daily mean temperatures, on extracting the maxima and minima mean temperatures for the month, it was found that more maxima occurred after first quarters than before; the proportion of maxima to minima, on the *second* day after that phase, being more than 2·1 both at Dublin and Greenwich, for the respective periods of twenty-two and forty-three years. The twenty-four highest and lowest maxima and minima in the month at Greenwich were then taken for the same forty-three years, forty-eight per cent. found to occur at first quarter, and *minima only* before the day of the change. Similar results were obtained from the highest and lowest mean temperatures at Dublin, and at Toronto from 1843 to 1848.

Another point elicited during the progress of the inquiry was the recurrence of high and low temperatures on the same days of the lunation. Taking first the maxima and minima mean temperatures for the month during twenty years at Greenwich—from 1837 to 1846,—the whole number found recurring on corresponding days (many of them three and four times in each period of twelve lunations) amounted to 236, averaging about twelve for each year, or half the maxima and minima for the month. To illustrate the recurrence of high and low temperatures, several years were selected, which presented the strongest evidence of system. Thus, in the two consecutive years commencing November, 1847, and ending October, 1848, maxima and minima occurred:—In 1847: twice on the third day before new moon; twice on the second day before new moon; three times on the day after new moon; twice on the third day after new moon; three times on the second day before full moon; twice on the third day after full moon. In 1848: three times on the day of new moon; twice on the day after new moon; three times on the second day before full moon; twice on the day before full moon; twice on the fourth octant, or fourth day, after full moon. In the same years there were also, amongst many others, the following remarkable instances of reciprocity between opposite phases of the moon:—In December the minimum for the month occurred on the third day before new moon; in January the maximum on the third day before full moon; in February the minimum on the third day before new moon. And again, the maximum in September fell on the day after full moon. The minimum in October on the day after new moon. "In addition to this, the maxima and minima for the month were found to occur at intervals of rather more than seven, fourteen, or twenty-one days, and that for several successive months, viz., April, May, June, August, and September, and so in other years." In 1838, exactly ten years earlier: maxima or minima occurred three times on the third day after new moon; three times on the day after full moon; three times on the day of first quarter; and three times on the day of last quarter: that is to say, in twelve instances out of twenty-four *on four days of the lunation.*

At the Cape of Good Hope, reciprocity of action, and the recurrence of high and low temperatures, were even more frequent and systematic. Thus, in 1855, eight out of the twelve maxima for the month occurred at first quarter, and nine of the twelve minima at new or full moon. In 1842, nineteen maxima and minima out of

twenty-four occurred on eight days. In 1843, fifteen on seven days; in 1844, seventeen on six days; in 1845, eleven on four days. The recurrence of maxima and minima at Toronto and Madras was equally marked.

Mr. Harrison considered that the dispersion of clouds under full moon may be now taken as a fact, on the testimony of Humboldt, Sir J. Herschel, Mr. Johnson (the Radcliffe observer at Oxford), and others. Mr. Johnson having also noticed that this cloud-dispelling power commences about the fourth or fifth day of the moon's age, and lasts till she approaches the sun, the same distance on the other side; that is to say, the influence takes place at that time as well as at full moon, though not necessarily continuously. Mr. Nasmyth also, who was considered a valuable witness, from his long-continued observation of the moon for the purpose of mapping its surface, was quoted as having satisfied himself—That clouds disappear when the moon is about four days old; and also that when this is the case for any length of time at new moon, the sky is clouded to a corresponding extent at full moon: another instance of the principle of reciprocity. Several well-known observers were also mentioned as having noticed the remarkable clearness of the morning of the 13th of September, or the fifth day after new moon. And lastly, even M. Arago's explanation of the popular notion among gardeners round Paris, that the moon which, commencing in April, becomes full in May, destroys their tender plants, it was thought might be quoted as evidence of lunar influence on the atmosphere, though given by him as a simple statement of the effects of terrestrial radiation on early vegetation.

Mr. Harrison, in conclusion, expressed his belief that the remarkable regularity of the recurrence of a fall before first quarter is due to the clearing of the atmosphere at that period, and the rise after first quarter to a more cloudy state of the sky. That the same effect is not so evident on the curves at the period of full moon, he considered might be due to the greater reciprocity of action which takes place at the syzygies, or new and full moon.

The President of the Section observed, that the additional facts Mr. Harrison had now adduced must be considered strongly confirmatory of the view he so ably advocated. That the moon exercised an influence upon the weather, and particularly on the formation or dispersion of clouds, was, as all knew, a very generally prevailing opinion; the sailors even had a common saying, "that the full moon ate up or devoured the clouds;" and Sir John Herschel had somewhere admitted that the nights about full moon, particularly at certain seasons of the year, were remarkably cloudless. This indirect influence, then, being admitted, it became more important to trace it, as Mr. Harrison was doing, to an influence upon the temperature.

THE EYE-BALL OF DIFFERENT ANIMALS.

Mr. T. Nunneley has read to the British Association, a paper "On the Form of the Eye-ball, and the relative position of the Entrance of the Optic Nerve into it in different Animals." Mr. Nunneley observed that the orbits are much larger than the eye-balls, and that their axes diverge considerably in an outward direction, while those of the two eyes are perfectly parallel. The eye-balls lie in the fore-part of the orbits, and according as they are more or less prominent, and more or less covered with the lids, do they appear to be larger or smaller. The eye of the infant is larger, in proportion to the size of the body, than that of the adult; but it is by no means certain that the eye of the male is larger proportionately to the size of the body than the eye of the female. By some *anatomists the human* eye is described as a spheroid, the *diameter of which, from* before to behind, is greater than in any

other direction. He had measured a great number of eyes, of the human subject as well as of animals; and he found that, wherever there was a departure from the spherical figure, it was in the direction contrary to that which had been commonly stated. In some instances the difference between the two diameters was scarcely perceptible; in all, where a distinction was observed, the transverse was the greatest.

He had prepared a set of tables (which were printed), containing the result of the measurement of 200 eyes of various creatures. "In conclusion, Mr. Nunneley said—The measurements, I think, clearly prove that whatever part the fibres of the optic nerve play in the phenomena of vision—and they, in all probability, only convey to the sensorium the impression received by the true retinal elements—the greatest number of them are distributed on that part of the eye-ball where there is the greatest range of vision, and that the largest expanse of retina is on that part of the ball opposite to where objects are placed, and consequently it is where the visual images of them must fall. Thus, the extent of vision is always in conformity with the space of retina on that side of the optic nerve; and as the rods and cellules appear always to correspond in abundance with the fibres, that side of the retina which receives the greatest number of images is most exercised, or where the range of vision is the greatest, is always the largest. That this is a fact, I think a careful comparison of the position of the eyes in the head, the size of the eye-ball, and the exact position of the entrance of the nerve into it, with the mode of life and habits of various creatures, will render more obvious than a casual glance would do."

To mention only a few instances as illustrations:—Man, from the erect position of his body, the horizontal placing of his eyes, and his habits, has a more panoptic range than any other creature (of course in this consideration all motions of the head, neck, and body of the animal must be excluded, and those of the eye-balls alone admitted). In him, the optic nerve enters the ball not far from the centre, leaving, however, a somewhat shorter space on the inner and lower parts of the retina than on the upper and outer. Now, while man enjoys a free range of vision *above* the horizontal line, there are far more occasions for him to look at objects below than above this line, and thus mere visual images are projected to the upper and outer sides of the entrance of the optic nerve oftener than to the inner and lower sides of this spot. In the Pig, who sees at no great range before him, and who seeks his food with the snout almost always in the ground, whose head and eyes are consequently for the most part downwards and near to the ground, the nerve enters the ball more outwardly and much lower than it does in man. The Pig wants not to see far before him, but he does require while grubbing to look behind him, from whence danger comes. So with the timid herbivorous animals; look at the entrance of *the nerve* in the Bullock and Sheep, who pass so much time with the *head in a dependent* position near to the ground, with the eye directed *upon the surface,* in open plains, where danger usually comes from

behind; in them the upper and inner sides of the retina are much larger than the lower and outer portions; while in the Deer, who lives in more wooded places, where danger is also from the front, but who, like the Bullock, has the head downwards in feeding, though the inner or anterior side of the retina is still larger than the posterior, it is so to a much less extent than it is in the Bullock—while the upper portion still continues as proportionately large as it is in Sheep and Bullocks. On the contrary, in the Horse, who is not so preyed upon, who carries the head erect, and observes all around, the nerve enters the eye more nearly in the axis. In Birds, with few exceptions, the upper portion of the retina is much more considerable than the lower parts; but the anterior and posterior portions vary much in different genera. Those whose locomotion is performed principally by the feet, and whose range of habitation is very small, as the common Fowl and Turkey, have the inner or anterior portion very considerably greater than the outer or posterior. Those birds whose range is greater, and who use the wings for progression, but who do not wander very far, as the Grouse and Partridge, have much less difference in the two portions of the retina; while in those birds whose flight is far and prolonged, as the Crow, Rook, Swan, Goose, and Duck, the entrance of the nerve is very nearly in the centre of the ball. So in reptiles: in the Turtle, who only requires to see immediately before and under him, the outer and upper portions of the retina are very much the larger.

In the more active Alligator, Frog, Toad, and Chameleon, while the upper portion maintains its size, the outer and inner parts are more nearly equal. In those creatures whose habitation is for the most part underground, as the shrew and the mole, the eyes are so small as to have led Magendie to assert that the Mole is without the organs altogether, which is not the fact, for I have found all the essentials of an eye, even true retinal elements, optic nerve, and a well-developed choroid. Yet the organ is so minute and concealed by the skin and hair, as probably only enables the creature to discern the light, which is all that it requires, for, living underground, where it seeks its prey, it obviously must depend upon the acuteness of other senses than of sight for its living.

Though in the individual there is usually some proportion between the size of the eye and the body, taking different classes and genera, the size of the animal is very little guide to that of the eye, the proportions between the two being determined by other considerations than that of the bulk alone of the creature; for though, as a whole, the eye in Fish bears a larger proportion to the whole body than it does in other divisions of the animal kingdom, and the eyes of Birds are, as a class, much larger than those of Mammalia or Reptiles, yet amongst the different genera of all these classes there are very great differences, determined, apparently, by the following considerations, amongst others not so obvious. When the creature lives in feeble light, yet moves actively about, and is guided in its locomotion by *the sense of sight, as in* nocturnal Birds and Animals and Fish, the *eye is very large,* apparently to take in a large quantity of the feeble

light; on the contrary, where the creature is guided in its movements by other senses, then the eye is very small, as in the Bat, the Mole, the Shrew, and the Eel. Where vision penetrates to a long distance, and where the eye enjoys great power of overcoming the aberration of parallax, the eye is large, as in rapacious Birds. When the brain and intellect are more developed, the size of the eye diminishes, and the two eyes become more parallel, as in Man and the higher Mammalia. Where animals are feeble, timid, have but little defensive power, and are preyed upon, the eye is usually very large, as in the Hare, the Conies, the whole Deer tribe, and many of the other ruminants. Where the animal is not predacious, and its size and strength are such as to protect it from being preyed upon, the eyes are commonly small, as in the Whale and the Elephant: in the latter the eye is even smaller that it is in the horse, and scarcely larger than in the Eagle.

Mr. Nunneley has also read to the Association, a paper "On the Structure of the Choroid Coat of the Eye, and more particularly on the character and arrangement of its pigmentary matter." The choroid coat is the dark tissue interposed between the delicate sentient retina and the hard dense sclerotic, and co-extensive with the latter. It begins at the entrance of the optic nerve by a round aperture with a distinct edge, in close apposition with the nerve, but not organically connected with it, and passing forward as far as the junction of the sclerotic and cornea, where as choroid proper it terminates. It there comes in connexion with the ciliary circle or muscle, the ciliary body and the iris. The choroid is essentially a vascular membrane, being made up of blood-vessels, colouring matter, and a modified white fibrous tissue. The choroid universally provided the pigmentary nigrum, and is of a deep bronze colour approaching to black. The pigment was described as consisting of two distinct forms of cells—on the inner surface the choroid, of true hexagonal cells, and in the tissue and on the posterior surface of stellate cells. He did not admit, however, that they were true cells. The use of these cells was to destroy the light as soon as it had acted on the retina, and they were the most perfect absorbers of light of any substance in nature that he knew of. From the account he gave of the arrangement of the pigment, it afforded what he considered a satisfactory anatomical explanation of an abnormal condition of the eye which had hitherto not been understood, viz.:—*Muscæ volitantes*. The figures of those motes he believed to resemble exactly portions of the choroid coat when teased out, and they might be expected to appear and disappear with the varying condition of the vessels arising from disordered stomach or the cerebral circulation; and be cured by whatever corrects those conditions; or the muscæ might result from different organic changes in the choroid coat which are incapable of being removed.

THE NERVOUS SYSTEM.

In one of Dr. Brown-Séquard's recent Lectures, he exhibited Guinea-

pigs which had been experimented on some months ago by cutting certain nerves; the hinder limbs became paralyzed, but in time the animals recovered the power of voluntary motion, attended, however, with a very curious result—the operator could put them into a fit of epilepsy whenever he pleased. It appears that by the cutting of the nerves the animals lose sensation except in one cheek, and if that spot be irritated a fit is the immediate consequence. Another noticeable particular is, that the lice which infest the animals congregate on that spot, and nowhere else. Whether it be that there is more warmth or more perspiration than on other parts of the body, is not known; at any rate, physiologists are agreed as to the singular and suggestive nature of the phenomenon. It appears, moreover, that if the sensibility of the sensitive spot be destroyed, then the Guinea-pig ceases to be liable to epilepsy. Applying this fact to human physiology, Dr. Brown-Séquard says that there is in the human body a spot, discoverable, as he believes, by galvanism, which, if deprived of its sensibility, would, in like manner, completely prevent attacks of epilepsy.—*Chambers's Journal.*

RACES OF MAN.

At the late Meeting of the British Association, Mr. Wright, one of the secretaries, read a lengthy and carefully-compiled paper, which had been prepared by Mr. John Crawfurd, of London, one of the vice-presidents, "On the Effects of Commixture, Locality, Climate, and Food on the Races of Man." The writer gave a comprehensive review of the commixture of various nations, its effects on the mental faculties of the different populations, their physical characteristics, and language, &c. He glanced next at the effects of a change of climate upon any particular race. It did not appear, he said, that colour and the more prominent physical attributes, or mental capacity, had any necessary connexion with climate; nor did he think that climate altered the physical form and mental faculties of a race transferred from its original locality to a new one. He supported this statement by a long array of arguments, in the course of which he observed that the question whether an European race was capable of living and multiplying in a tropical or other hot region had been settled in the affirmative on a large scale in America. After quoting the opinion of Baron Humboldt, showing that heat had very little effect on the European constitution, Mr. Crawfurd applied this portion of his paper to disprove the statements which he said had been repeatedly asserted, that the British possessions in India were unfit for the permanent residence of Englishmen. He pointed out at some length that the varieties of climate had a great influence upon the mental powers of a people, and proceeded to consider, under the last head of his paper, the question of diet in relation to the physical and mental character of a people. The physical character of a race, he said, did not seem to be in any respect altered by the nature of the vegetable diet of which it partook, provided the quantity were sufficient and the quality wholesome; but

when the question of the diet of a people related to mental development, the quality assumed an important aspect. No race of man, it might be safely asserted, ever acquired any respectable amount of civilization that had not some cereal for a portion of its food.

POLARIZED CONDITION OF MUSCULAR AND NERVE FIBRE.

MR. H. F. BAXTER has communicated to the *Edinburgh New Philosophical Journal*, No. 14, a paper on this inquiry. Having arrived at the conclusion, in a previous paper (says Mr. Baxter), that the muscular and nervous tissues are, during life, in a peculiar state or condition, which has been termed Polarized, the following question naturally arises—Can this state, dependent as it evidently is upon nutrition, be increased by any artificial means? That it may be diminished or easily destroyed is to be inferred from the fact, that whatever interferes with the proper nutrition of a muscle or nerve, or disorganizes their structure, whether by mechanical or chemical agencies, destroys also the conditions upon which the existence of the muscular or nerve currents depends; and it is, it may be observed, from the manifestation of these currents that the existence of this polarized condition is inferred. It is reasonable, therefore, to suppose, that it might be by the employment of the electric force (or current) that we should perhaps obtain some evidence to assist in solving this problem.

We have not space for the details. The only conclusions, (says the author,) that can be deduced from the foregoing investigations, contained in the former as well as present papers, are the following:—

1st. That we have no evidence of being able to increase the polarized condition of the nervous and of the muscular tissue by artificial means, such as the electric current; but it is highly probable.

2nd. That an increase of this polarized condition may arise from an increased action of those changes which take place in the living animal, such as nutrition, being the same means by which it is produced and maintained in the living animal.

Before acceding to these conclusions, it may be reasonably asked, have we not other evidence besides that afforded by means of the galvanometer to indicate an increase in the polarized condition of the nerve? Do not the tetanic contractions which are observed in a limb whose nerve has been subjected to the action of an electric current (inverse), indicate an increased action of the nerve? Previous to discussing this question, which will be considered in the concluding remarks, the following experiment was performed:—

A current from six of Grove's cells was passed through the limb of a galvanoscopic frog in the inverse direction, and as soon as tetanic contractions were produced, the nerve was divided at the junction of the nerve with the muscles of the limb; the tetanic contractions ceased. The two ends of the divided nerve were now placed in apposition, but no tetanic contractions ensued. This inverse current was *again* allowed to pass for some time through the nerve thus united, *but no tetanic contractions* occurred upon the breaking of the circuit. *Great care*, however, is required in this experiment to divide

the nerve at the exact point where it emerges from the muscles, as pointed out by Matteucci, otherwise the tetanic contractions take place.

The results of this experiment only tend to confirm what has been already satisfactorily proved by others, that the continuity of the nerve fibre in the nerve leading to the muscle, is necessary for the conduction of the impression excited at the distal end of the nerve in order to arouse muscular contraction. It need scarcely be added, that the muscular and nerve currents may, however, be obtained under these circumstances between the separated portions.

NEW THEORY OF SOUND.

THE Rev. S. Earnshaw has communicated to the British Association a paper "On the Mathematical Theory of Sound," in which he announced that he has succeeded in integrating the differential equation of sound without approximative assumptions; that he has, in fact, obtained its *exact* integral; and in the result has possessed himself of the key to the various properties of sound. Among several others, it was stated that the exact integral accounts for the great difficulty which experimenters have found in obtaining accordant velocities of sounds,—for the sweetness of musical sounds,—for the rapid decay of violent sounds as they progress, —and proves that the velocity with which a sound is transmitted through the atmosphere depends on the degree of violence with which it was produced, and not (as in light) on the length of the wave; so that sounds of every pitch will travel at the same rate, if their genesis do not differ much in violence; but a violent sound, as the report of fire-arms, will travel sensibly faster than a gentle sound, such as the human voice. This last property the author stated to have caused him much trouble, in consequence of its being directly opposed to the testimony of almost every experimenter. For many affirmed, as the direct result of their observations, and others assumed, that all sounds travel at the *same* rate. Fortunately, it transpired at the meeting that in Captain Sir J. Franklin's Expedition to the North, whilst making experiments on Sound, during which it was necessary to fire a cannon at the word of command given by an officer, it was found that the persons stationed at the distance of some miles to mark the arrival of the report of the gun, always heard the report of the gun before they heard the command to fire; thus proving that the sound of the gun's report had outstripped the sound of the officer's voice; and confirming in a remarkable manner the result of the author's mathematical investigations.

Professor Stevelly said that when Mr. Earnshaw had, on the previous evening, told him of the interesting fact observed and recorded by Captain Parry, it had occurred to him that Sir James Ross having been with Parry in all his expeditions, would be likely to have personal cognizance of the fact; as soon as he met him, therefore, he inquired, and was much gratified to find that he was the *officer who had* commanded the gun on the occasion referred to. *They had* been engaged in experiments on the velocity of

sound, Parry and his party at a measured distance of four miles from the gun, and they gave a signal when they were all prepared by flashing a musket.

Sir James Ross said he had also preserved a record of the difference of time of seeing the flash and hearing the report of the musket, and would take care to furnish them to Mr. Earnshaw.

The Astronomer-Royal said, that while he had no doubt whatever of the general accuracy of the conclusions at which Mr. Earnshaw had arrived, and while he fully admitted their importance, he could not subscribe to all that he had said. In his historical sketch of the steps by which we had arrived at our present knowledge of the subject, he could not admit that the method of Newton was wrong; the fact being, that it was a strictly correct solution of one case of what was a very general problem. The method of Newton was the very basis of all our modern methods; and he looked upon that portion of the second book of the *Principia* as a monument of the genius of Newton, which he was very sorry to see was beginning to be much less attended to in our Universities than it deserved. He could not also admit that so little had been done by the methods heretofore in use; and although he considered a vigorous integration of the equation to be very important, yet he considered much had been done even by himself by using the method of successive approximations, similar to that adopted in the Lunar and Planetary Theories. Of this he adduced several examples, such as those in his article on Waves and Tides in the *Encyclopædia Metropolitana*, and the non-reflexion of breaking waves; while at the same time, like the whisper in the gallery of St. Paul's, they were conducted along a smooth wall up to which they moved very obliquely; also bores and quiet tide-waves, and some others. He likewise could not subscribe to the objection that assuming the differential co-efficient to be unity required that the air should be so constituted that pressure in a given direction should be accompanied by a motion of the particle in the opposite direction, for this frequently happened where the particle was already in motion.

Mr. Earnshaw explained that what he meant to convey was, that the pressure should be the originator or cause of motion in the opposite direction.

The Astronomer Royal—As the method, however, of Mr. Earnshaw was not yet placed fully before the Meeting, he hoped to be able to form a more correct judgment of it than he was now able to do, when he had an opportunity of examining it in all its details.

SONOROUS FLAMES.

PROFESSOR W. B. ROGERS observes:—The production of a musical sound by a small flame of hydrogen gas burning within a tube has long been one of the most familiar of lecture-room experiments. Professor Faraday, early in his marvellous career of discovery, showed that this musical vibration was not confined to hydrogen, but could *be produced with* flames of carbonic oxide, olefiant and common *illuminating gas*, as well as several other gases and vapours; and he

was the first to give a philosophical theory of the sound, by rendering it probable that, in the conditions of the experiment, the flame resolved itself into a series of little explosions, which, succeeding each other at very small and equal intervals, gave rise to regular and therefore musical vibrations in the tube. This theory, afterwards confirmed by an experiment of Professor Wheatstone, in which, with his well-known revolving mirror, he rendered visible the intermitting combustion of the singing flame, has lately received a further illustration from Professor Tyndall's ingenious arrangement for observing the successive images of the flame as reflected upon a screen.

The recent beautiful experiments of Count Schaffgotsch and Professor Tyndall, proving that in certain conditions the flame is strongly impressible by external sounds, have given a new and unexpected interest to the subject, as is well shown in the curious observations of Professor Leconte in the January number of the *American Journal of Science;* and from time to time communicated to the Boston Natural History Society and the American Academy. See the experiments quoted in the *Edinburgh New Philosophical Journal*, No. 16.

ON FLUORESCENCE PRODUCED BY THE AURORA.

PROFESSOR ROBINSON writes from the Observatory, Armagh:—"On the 14th of March, an aurora was visible here of more than the average brightness. At 11 P.M. it showed an arch extending from W. to N.E. by E., which emitted a few yellow streamers; and the sky above it was covered with diffused light, over which brighter portions flickered like waves, extending several degrees beyond the zenith. I availed myself of the opportunity to try whether this light was rich in those highly refrangible rays which produce Fluorescence, and which are so abundant in the light of electric discharges; and I found it to be so. A drop of disulphate of quinine on a porcelain tablet seemed like a luminous patch on a faint ground; and crystals of platinocyanide of potassium were so bright, that the label on the tube which contained them (and which by lamplight could not be distinguished from the salt at a little distance) seemed almost black by contrast.

"These effects were so strong in relation to the actual intensity of the light, that they appear to afford an additional evidence of the electric origin of this phenomenon."—*Philosophical Mag.*, No. 100.

EXPERIMENTS ON RADIANT HEAT.

THE object of these Experiments was to compare together the radiations from the polished surfaces of different bodies, all having the temperature of 212°. In order to heat the bodies, a tin box was used, double-sided and double-bottomed, or a box within a box. Water being kept boiling in the interval, the interior chamber was found to have a temperature of nearly 212°; and on the bottom of this chamber the bodies to be experimented on were placed. When being used, these were taken out of the chamber and placed before the sentient pile of a thermo-multiplier, the galvanometer needle con-

nected with which was immediately deviated from its zero position. The extent of the first swing of this needle was taken to denote the quantity of heat that fell upon the pile; and this deviation taking place in about 12 seconds after the substance had been taken out of the boiling water apparatus, it was found that during this small portion of time the substance might be supposed to keep its original temperature of 212°, its cooling being so small as to be neglected.

In order that different substances might be compared with one another, the same amount of heated surface was always presented to the pile.

In the first group of experiments, the quantities of heat radiated from polished plates of different substances (heated to 212°) were compared with the quantity radiated from a similar surface of lamp-black at the same temperature. It was found that glass, alum, selenite, and thick mica, radiated very nearly as freely as lamp-black; while the radiation from rock-salt was only 15 per cent. that from lamp-black.

In the second group of experiments, the quantities of heat radiated at 212° from polished plates of the same substance, but of different thicknesses, when compared with one another.

It was found that thickness made a scarcely perceptible difference on the quantity of heat radiated by glass, a somewhat greater difference on the quantity radiated by mica, and a very sensible difference on the quantity radiated by rock-salt—a thick plate of this substance giving more than a thin plate, in the proportion of nearly 5 to 3.

The third group of experiments showed that heat from a polished plate of any substance is less transmissible through a screen of the same substance than heat from lamp-black; this difference being exceedingly marked in the case of rock-salt. The same rock-salt screen which transmits ⅞ths of the rays which fall upon it from heated lamp-black, transmits only ⅓rd of the rays that issue from heated rock-salt.

The fourth group of experiments showed that heat from a thick plate of any substance is more transmissible through a screen of the same substance than heat from a thin plate.

These four groups of experiments show that the radiations from diathermanous bodies, such as rock-salt, is much less copious than that from bodies of an opposite nature, such as glass; and also that the radiation from diathermanous bodies increases with the thickness of the plate.

It was shown that all these results follow from Prevost's theory of exchanges. For if we suppose a plate of rock-salt placed in a chamber of lamp-black, all at 212°, then, since the temperature of the rock-salt remains the same, it must radiate as much as it absorbs. But since it absorbs but a small proportion of the lamp-black heat, it will radiate but a small proportion; and since a thick plate of rock-salt would absorb more than a thin plate, it would also radiate more.

The radiation of such a thin plate is therefore equal to its absorption.

It was then shown that for every separate ray of which the heterogeneous radiation of 212° is composed, this equality must hold; and that for every such ray the absorption of such a thin plate = its radiation.

It was shown that the reason why rock-salt is opaque to heat *from rock-salt is* this: There are a few rays out of the total lamp-

black radiation of 212°, for which rock-salt is opaque; these rays, therefore, are rapidly absorbed by a thin plate of rock-salt; but the radiation being equal to the absorption for every kind of heat, this thin plate will chiefly radiate such rays, which will consequently be stopped by a screen of rock-salt.

In conclusion, it was shown that if we have a chamber, whose walls are composed of different substances, kept at a uniform temperature, the heat radiated and reflected together from any portion of the surface of its wall will be independent of the nature of the substance of which that surface is composed; the only difference being, that in the case of a metal it will be chiefly reflected and little radiated heat, while in the case of lamp-black it will be altogether radiated heat. But for all substances, radiated + reflected heat = a constant quantity.—*Proc. Royal Soc. Edinburgh.*

CONTRIBUTIONS TO MICROSCOPICAL ANALYSIS.—TOBACCO.

DR. LAWSON has called attention to the imperfect descriptions that existed of the histological characters of Tobacco, and the consequent liability to error in Microscopical Analysis on the part of those who depended upon books for their knowledge. It has been customary to characterize the tobacco as distinguished by its hairs being "glandular," or having an "enlargement" or "roundish swelling" at the tips; but this very imperfectly indicates the peculiar structure of these hairs, which, although extremely variable in size and general form, present certain characters in their lower cells, and in the structure of the glands at their tips, which are very constant and of great practical value. These characters were shown by a series of microscopical drawings from various species of Nicotiana, as well as from manufactured tobacco. The characteristic hair of the tobacco-leaf varies from 1-20th to 100th of an inch in length, and is generally thick and gouty at the base, and tapering towards the extremity where the glandular structure is placed; that structure is of an oval or rounded form, and consists of a few closely-packed but well-defined cells, which are very much shorter than the other cells of the hair. The elongated cells of the body of the hair (of which the lower one is most characteristic, on account of its very large size,) contain fine colourless granular matter, and generally nuclei; but the secreting cells are well furnished with colouring matter of a reddish-brown, but sometimes of a green colour. A one-inch object glass, recommended by Hassall for the examination of tobacco, is usually insufficient to show the *structure* of the gland, and the mere presence of "glandular hairs" proves nothing, these being common in plants. It is also necessary to keep in view that many small hairs occur on tobacco-leaves, which are normally without glands. The glandular hairs are most abundant at the tips of the shoots, and especially on the calyx and flower-stalks of the tobacco. Dr. Lawson, in calling attention to the remarkable prevalence of glandular hairs on the surface of plants in many families, observed that *we have here a striking* illustration of the view which he endeavoured *to explain* in the summer of 1857 — viz., that the

secreting structures of plants are invariably formed by *epidermal cells*, even where these structures are deeply imbedded in the plant's tissue. To the fact that epidermal hairs are so frequently organs of secretion, Gasparrini has recently added the additional one, that they are also organs of absorption.—*Proc. Botan. Soc. Edin.*

ON VISION.

SIR DAVID BREWSTER has read to the British Association, a paper "On Vision through the Foramen Centrale of the Retina." "At the Meeting of the British Association which was held at Belfast, (said Sir David,) I gave an account of a case of vision, in which it was performed entirely by the choroid coat, and through the foramen centrale of the retina. The space of distinct vision as ascertained by the number of minute printed letters which the patient could read was 4½°, the angle subtended by the foramen, which I had previously determined by experiment. In this case the paralysis of the retina was permanent, and the patient was blind, with the exception of the small amount of vision which he enjoyed through the foramen. In the case to which I now call the attention of the Section, paralysis was temporary, and was accompanied with severe headaches; but as soon as the patient recovered her health, the retina resumed its usual functions. In order to find the area of distinct vision, the patient observed with care the number of small and sharply printed letters which she could read at a certain distance from the eye; and upon measuring the breadth of these letters, and their distance from the eye, I found that they subtended an angle of 4½°, corresponding with the size of the opening in the retina. These facts, when viewed in connexion with those which I described at the Swansea Meeting, may throw some light on the functions exercised by the retina as a whole, or by some of its individual layers. I have placed it beyond a doubt that the membrane, whether choroid or retina, which occupies an area of 4½°, at the extremity of the optical axis of the eye, is, in certain cases, *less retentive* of luminous impression, and, in others, *more retentive* than the retina. If the microscope proves that there is no retina corresponding to that area, we must consider the choroid coat as the seat of vision. If it should prove that any one of the layers of the retina occupies that area, while the rest are wanting, it will be manifest that that layer is the seat of vision, or rather of luminous impressions."

Mr. Nunneley said that he had just read a paper in another Section, in which his object was to show that it was a mistake, arising from dissecting the eye after decomposition had commenced, to suppose there was a foramen or hole in the retina of man, of certain kinds of monkeys, and of lizards, in the direction of the optic axis. He believed it to be a mistake; he had dissected the eyes of fresh subjects soon after death without finding any trace of it. Besides, he could not conceive that all other animals, who confessedly had *not this foramen*, were without the power of distinct vision.

Sir D. Brewster replied, that he was not an anatomist, and was

therefore unable to enter into a discussion with Mr. Nunneley, whose views and opinions he admitted were entitled to the most careful consideration. But Sir Everard Home had been the first to detect this foramen, and other anatomists of the greatest eminence had after him admitted its existence. Söemmering had figured and given its dimensions,—and as to the recency of the subject, one case in which it had been found was the eye of a criminal who had been executed in Edinburgh in the prime and vigour of manhood and of health, and the examination of his eye had taken place within two hours of his death, so that no more favourable case could be conceived. But to waive the anatomical question, he (Sir D. Brewster) had felt convinced that the structure of the eye about the optic axis in a sphere embracing a circle of 4½° was physically distinguished from the rest of the coats of the eye by characters which could not be mistaken,—of which he had given several at the Swansea and Belfast Meetings of the Association, and which he now briefly recapitulated.

IMPRESSIONS ON THE RETINA.

Sir David Brewster has read to the British Association, a paper "On the Duration of Luminous Impressions on certain Points of the Retina." It is well known that the duration of luminous impressions on the retina is one-third of a second for white light of ordinary intensity. In the report of the Belfast Meeting, (says Sir David,) I have shown that the small circular area at the end of the axis, whether it be retina or choroid, retains light longer than the general retina, after the eye has been exposed to light; and I have recently observed that certain points of that membrane, situated apparently near its termination at the ciliary processes, have even a greater retentive power. In order to observe this curious phenomenon, we must extinguish, suddenly, a gas-flame to the light of which the eye has been for some time exposed. We shall then observe a number of bright luminous points arranged in a circle, the diameter of which is about 72°. These bright points, or stars, apparently placed at equal distances, vanish so quickly that I have found it very difficult to determine their number. They may amount to 15 or 20. I have sometimes observed them upon extinguishing a candle, and also upon quickly shutting the eyes. The parts of the retina from which these points of light emanate are probably places where the retina is attached to the ciliary ring, or other parts in the interior of the eye, and may therefore be detected by the anatomist.

OPTICAL ILLUSIONS OF SPECTRAL PHENOMENA.

Mr. H. Dircks has described to the British Association, an apparatus invented by him for exhibiting Optical Illusions of Spectral Phenomena. The author, after quoting some passages in Sir David Brewster's *Natural Magic*, in which the author had intimated that *reflexion by concave specula* must form the basis of all *spectral illusions by reflexion*, and pointing out the inconvenience of using these

for producing images of living and moving persons, in consequence of their inverting objects, stated that he had contrived a means by which living actors, some the real persons, others the images of persons concealed from the direct view of the spectators, might be formed by a large plate of glass dividing the room in which the exhibition was made; the spectators being in a darkened portion above, but at one side of the glass plate, while the living persons on the other side of it could be seen quite clearly through the glass, and the images of other persons walking about in the room under them seen by reflexion, would appear in the same place as the living persons seen directly; and could be thus made to appear to perform most amusing spectral feats, such as passing through walls, into and coming out of the living actors, and so on.

NEW LAW OF BINOCULAR VISION.

THE Rev. J. Dingle has communicated to the British Association, this new law, the object of which is to obviate the imperfect vision which would sometimes arise from the difference of the pictures in the two eyes. In some cases this difference would lead to great inconvenience and confusion. It sometimes happens, for instance, that in looking at a field of view at some distance, objects considerably nearer are so interposed as to present themselves in the picture formed in one eye and not in the other. Thus, in looking at a landscape, if the finger or any other object is held before one eye, the image of it from the one retina is superposed in the *sensorium* on a part of the landscape formed in the other eye. On mere physical principles, this might be expected to blot out or greatly confuse that part of the landscape upon which it was placed; but upon trial this is not found to be the case, as that part is merely a little dimmer than the rest from being seen only with one eye, but is equally distinct and as truly coloured. By various experiments the author had ascertained that this was the result of a peculiar power of the will, by means of which the mind is enabled, when two different images are superposed in the *sensorium*, to select whichever it pleases, to bring that object into view, and entirely to obliterate the other,—it sees, in fact, whichever it wills to see, and the other image, simply by being neglected, becomes invisible. In ordinary vision, the determination of the image to be seen is effected by the same act of the will which determines the position of the optic axes; but by certain arrangements which were indicated, both images may be made to have the same relation to the optic axes; and as the predisposition to select one or the other is thus obviated, it is made indifferent to the mind which of the two images that occupy the same place in the *sensorium* it shall see. When these arrangements are made, it is found that mere efforts of the will can easily bring either the one or the other into view. The importance of this law, which enables the mind to select its image, was pointed out in different cases of ordinary vision. It obviates the difficulty already adverted to, of having two different pictures on the same spot; it has not improbably an important influence in producing the general stereoscopic effect; it

also, to some extent, remedies the effect of squinting, by obliterating the picture in the imperfect eye, which could not be else done without shutting it. The effect of the law, in some extraordinary cases, was also noticed, especially in the power of the will to fix images on the sight, as Sir Isaac Newton instances in his own case. (See his *Life*, by Sir David Brewster.) The author pointed out the great interest of the subject, not only in its practical aspect, but also as having an important bearing on the connexion between mind and matter.

Professor Stevelly then related an instance of a circumstance which recently occurred to himself, and which he was entirely unable to account for on any physiological principles. This was a moving having become permanently impressed on the retina, the first instance ever heard of by Professor Stevelly. Notices of fixed impressions, particularly after having been dazzled, are now common enough.—*Athenæum Report.*

OPTICAL PROPERTIES OF PHOSPHORUS.

DR. GLADSTONE has read to the British Association, a communication by himself and the Rev. T. Pelham Dale, "On some Optical Properties of Phosphorus." He said that phosphorus was known to be highly refractive and disfusive. Its refractive index had been determined at 2·125 or 2·224, a number scarcely exceeded by that of diamond or chromate of lead. This determination was made without reference to temperature, and was that part of the spectrum measured indicated. Their own experiments, made with instruments belonging to the Rev. Baden Powell, produced numbers which showed not merely a very high refractive power, but an amount of disfusion unknown in any other substance. The disfusive power was nearly twice that of bisulphide of carbon, and largely exceeded that of even oil of cassia; its only rival was that assigned to chromate of lead, but some doubt seemed to rest on that determination. The determinations of the disfusion of phosphorus made by persons experimenting had indicated an amount scarcely exceeding that of bisulphate of carbon, but a difficulty attending the examination of phosphorus would sufficiently explain this. Phosphorus in a liquid condition had apparently never been examined, as difficulties had arisen from its inflammability, and from the action on cement. An examination of the properties of liquid phosphorus showed a considerable diminution of both the refractive and the disfusive power, it not being in direct ratio with the diminution of density. Liquid phosphorus exhibits a greater amount of sensitiveness than had been observed in any other substance, and it was evidently greater at the high than at the low temperatures. The effect of temperature on disfusion could not be accurately determined. A saturated solution of phosphorus in bisulphide of carbon was almost as refractive and disfusive as melted phosphorus itself. There was a certain want of clearness in phosphorus which prevented the lines being distinguished without great difficulty, which did not arise from any opacity, or from the crystalline character of solid phosphorus, or from unmelted

pieces floating about, for it occurred in a solution of bisulphide of carbon. The addition of phosphorus to bisulphide of carbon rendered the spectrum seen through it misty, according to the amount of phosphorus. This was not due to the great refraction, or the great disfusion, or the great sensitiveness, though this had undoubtedly something to do with it. To what was this due? Different specimens of phosphorus differ widely in respect to this property, and it was perhaps connected with some want of homogeneity in the substance. The phosphorus experimented on was generally colourless. It was a curious circumstance that yellow phosphorus cuts off the extreme red ray—this being the opposite of what yellow bodies usually did, and was remarkable also in connexion with the red modification of phosphorus.—*Literary Gazette Report.*

THE FIXED LINES OF THE SOLAR SPECTRUM.

DR. GLADSTONE has read to the British Association, some observations "On the Fixed Lines of the Solar Spectrum." The author exhibited three maps—the first, representing the fixed dark bands and lines in the extreme red portion of the spectrum; the second, those in the extreme lavender rays; and the third, those which make their appearance about the orange and yellow portion when the sun is close to the horizon, as described by Sir David Brewster. A long span of atmosphere absorbs also the more refrangible rays, but affects in no way the angular position of these lines. The moon's light shows exactly the same lines as the sunlight, and the dark bands in the orange and yellow equally appear when it traverses much air. That portion of the spectrum which with sunlight appears violet, has a lavender or even grey colour with moonlight. Attempts had been made to determine whether those lines were entirely due to the absorbent effect of the earth's atmosphere, by observations of stars, and of distant artificial lights, but the author thought without a conclusive result. The light from the edge of the sun's disc has just the same lines as that from the centre.—*Ibid.*

ON MOLECULAR IMPRESSIONS BY LIGHT AND ELECTRICITY.

PROFESSOR GROVE has read to the Royal Institution a paper on this inquiry. The term Molecular is used in different senses by different authors. It is here used to signify the particles of bodies smaller than those having a sensible magnitude, or as a term of contradistinction from masses. If there be any distinctive characteristic of the science of the present century as contrasted with that of former times, it is the progress made in molecular physics, or the successive discoveries which have shown that when ordinary ponderable matter is subjected to the action of what were formerly called the imponderables, the matter is molecularly changed.

The remarkable relations existing between the physical structure of matter, and its effect upon heat, light, electricity, magnetism, &c., seem, until the present century, to have attracted little attention: thus, to take the two agents selected for this evening's discourse, Light and Electricity, how manifestly their effects depend upon the molecular organization of the bodies subjected to their influence. Carbon

in the form of diamond transmits light but stops electricity. Carbon in the form of coke or graphite, into which the diamond may be transformed by heat, transmits electricity but stops light. Leonard Euler alone conceived that light may be regarded as a movement or undulation of ordinary matter; and Dr. Young, in answer, stated as a most formidable objection, that if this view were correct all bodies should possess the properties of solar phosphorus, or should be thrown into a state of molecular vibration by the impact of light, just as a resonant body is thrown into vibration by the impact of sound, and thus give back to the sentient organ an effect similar to that of the original impulse.

In the last edition of his *Essay on the Correlation of Physical Forces*, (1855,) Mr. Grove has made the following remarks on this question: "To the main objection of Dr. Young, that all bodies would have the properties of solar phosphorus if light consisted in the undulations of ordinary matter, it may be answered that so many bodies have this property, and with so great variety in its duration, that *non constat* all may not have it, though for a time so short that the eye cannot detect its duration." The above conjecture has been substantially verified by the recent experiments of M. Niepce de St. Victor, of which the following is a short *résumé*:—An engraving which has been for some time in the dark is exposed to sunlight as to one half, the other half being covered by an opaque screen: it is then taken into a dark room, the screen removed, and the whole surface placed in close proximity to a sheet of highly sensitive photographic paper; the portion upon which the light has impinged is reproduced on the photographic paper, while no effect is produced by the portion which had been screened from light; white bodies produce the greatest effect, black little or none, and colours intermediate effects. Mr. Grove had little doubt that had the discourse been given in the summer instead of mid-winter, he could have literally realized in this theatre the Laputa problem of extracting sunbeams from cucumbers! While fishing in the autumn, in the grounds of M. Seguin, at Fontenay, Mr. Grove observed some white patches on the skin of a trout, which he was satisfied had not been there when the fish was taken out of the water. The fish having been rolling about in some leaves at the foot of a tree, gave him the notion that the effect might be photographic, arising from the sunlight having darkened the uncovered, but not the covered portions of the skin. With a fresh fish, a serrated leaf was placed on each side, and the fish laid down so that the one side should be exposed, the other sheltered from light: after an hour or so the fish was examined, and a well-defined image of the leaf was apparent on the upper or exposed side, but none on the under or sheltered side.

The number of substances proved to be molecularly affected by light is so rapidly increasing, that it is by no means unreasonable to suppose that all bodies are in a greater or less degree changed by its impact. Passing now to the molecular effects of electricity, every day brings us fresh evidence of the molecular changes effected by this agent. The electric discharge alters the constitution of many gases across which it is passed; and it was shown that by passing it through an attenuated atmosphere of the vapours of phosphorus, this element is changed by the electric discharge into its allotropic variety, which is deposited in notable quantity on the sides of the receiver. In this experiment, the transverse bands or striæ discovered by Mr. Grove, in 1852, are very strikingly shown. The glow which is seen on excited electrics, such as glass, was also shown by Mr. Grove to be accompanied with molecular change. Letters cut in paper, and placed between two well-cleaned sheets of glass, then formed into a Leyden apparatus, by sheets of tin-foil on their outer surfaces, and then electrified, by connexion for a few seconds with a Rümhkorff coil, had invisible images of the letters impressed upon the interior surface, which were rendered visible by breathing on them, and rendered visible, and at the same time permanently etched by exposure, after electrization, to the vapour of hydrofluoric acid. So, again, if iodized collodion be poured over the surface of glass having the invisible image, and then treated as for a photograph, and exposed to uniform daylight, the invisible image is developed in the collodion film, the invisible molecular change being conveyed to the molecular film, and rendering it, when nitrated, more sensitive to light in the parts where it has been in proximity to the electrical impression, than in the residual parts. Here we have a molecular change, produced first by electricity on the glass, then communicated by the glass to the collodion, then changed in character by light, and all this time invisible, and then rendered visible by the developing chemical agent. Mr. Babbage had observed that some plates of glass which had formed the ornamental margin of an old looking-glass, and were

backed by a design in gold-leaf covered with plaster of Paris, showed, when this backing was removed by soft soap, an impression of the gold-leaf device, which was rendered visible by the breath on the glass. Some of the plates had been kindly lent by him for this evening; and in one, Mr. Grove had removed a portion of the backing, and the continuation of the gilded design came beautifully out by breathing on the glass while in the frame of the electric lamp, and was projected (as were the previous electrical images) on a white screen. Of the practical results to science of the molecular changes forming the subject of this evening's lecture, a beautiful illustration was afforded by the photographs of the moon by Mr. De la Rue, which afforded, by the aid of the electric lamp, images of the moon, six feet diameter, in which the details of the moon's surface were well defined,—the cone in Tycho, the double cone in Copernicus, and even the ridge of Aristarchus, could be detected. The bright lines, radiating from the mountains, were clear and distinct. A photograph of the planet Jupiter was also shown, in which the belts were very well marked, and the satellites visible.

The following question was suggested by Mr. Grove:—As telescopic power is known to be limited by the area of the speculum or object-glass, even assuming perfect definition, as the light decreases inversely as the square of the magnifying power, a limit must be reached at which the minute details of an object become lost for want of light. Now, assuming a high degree of perfection in astronomical photographs, these may be illuminated to an indefinite degree of brilliancy by adventitious light. With a given telescope, could a better effect be obtained, by illuminating the photographic image, and applying microscopic power to that, than by magnifying the luminous image in the usual way by the eye-glass of the telescope? Can the addition of extraneous light to the photograph permit a higher magnifying power to be used with effect than that which can be used to look at the image which makes the photographic impression? In other words, is the photographic eye more sensitive than the living eye? or can a photographic recipient be found which will register impressions which the living eye does not detect, but which, by increased light or by developing agents, may be rendered visible to the living eye?

The phenomena treated of here, which are a mere selection from a crowd of analogous effects, show that light and electricity, in numerous cases, produce a molecular change in ponderable matter affected by them. The modifications of the supposed imponderables themselves have long been the subjects of investigation: the recent progress of science teaches us to look for the reciprocal effects on the matter affected by them. Few, indeed, if any, electrical effects, have not been proved to be accompanied with molecular changes; and we are daily receiving additions to those produced by light. Mr. Grove feels deeply convinced that a dynamic theory, one which regards the imponderables as forces acting upon ordinary matters in different states of density, and not as fluids or entities, is the truest conception which the mind can form of these agents; but to those who are not willing to go so far, the ever-increasing number of instances of such molecular changes affords a boundless field of promise for future investigation, for new physical discoveries, and new practical applications.

POLARIZATION OF LIGHT BY AMETHYST PLATES.

A PAPER has been communicated to the British Association, "On the Use of Amethyst Plates in Experiments on the Polarization of Light," by Sir D. Brewster. In order to determine the exact position of the plane of primitive Polarization, it was usual to observe when the intensity of the extraordinary image of the analyzing prism was a minimum; but as it is difficult to obtain light perfectly homogeneous, the light of this image could not be completely extinguished. In his experiments on the rotatory phenomena of quartz, M. Biot employed a coloured glass, which transmitted only the extreme red rays of the spectrum; but this method, owing to the great loss of light on the polarized pencil, was attended with so many inconveniences, that fifteen or twenty trials were required before he could determine the zero of his instrument. In order to remedy this evil,

M. Soleil interposed between the polarizing apparatus and the analyzing prism two plates of quartz of equal thickness, the one right-handed and the other left-handed. These plates were united so as to give the same tint when the plane of the principal section of the analyzing prism coincided with the plane of primitive polarization. This ingenious apparatus was submitted to the French Academy of Sciences in June, 1845, and has been used since that time by M. Senarmont and others in their experiments on polarization. In the year 1819, Sir David Brewster communicated to the Royal Society of Edinburgh the very same method of placing the principal section of the analyzing prism in the plane of primitive polarization; but in place of using two plates of right and left-handed quartz, he used a single plate of amethyst, in which the two kinds of quartz were combined, during the formation of the crystal. This piece of apparatus, which is obviously superior to that of M. Soleil, is thus described in the paper referred to:—"The properties of amethyst, which have now been described, render a plate of this mineral a valuable addition to our apparatus for conducting experiments on the polarization of light. If we wish to place the principal section of the analyzing prism exactly in the plane of primitive polarization, we have only to interpose a thin plate of amethyst like that shown in the figure, and if the tints of both sets of veins are exactly similar, the analyzing prism will have the required position. If the one set of tints is bluer or whiter than the other, or if there is the slightest difference between them, the position of the prism must be altered till that difference is no longer perceptible. If we wish to place a plate of sulphate of lime or any other crystal, so as to have its principal section in the plane of primitive polarization, the interposition of the amethyst plate will give us the same assistance, by indicating that the circular (rotatory) tints are not affected by it, whereas if we wish to place the axis of the sulphate of lime at an angle of 45° to the primitive plane of polarization, the amethyst will point out this position when the opposite circular tints suffer an equal change."

STEREOSCOPIC PICTURES FROM FLAT SURFACES.

A RECENT invention opens up an entirely new field for Stereoscopic Pictures, by rendering views taken from paintings or engravings as solid and apparently real as if they had been photographed from the subjects which the paintings represent. Till now no stereographic cards of engravings have been made, for the good reason that they would not have had any more relief than the engravings themselves, and would have quite wanted the charm of apparent reality which renders the stereoscope so popular.

NEW STEREOSCOPE.

AN important modification of Wheatstone's Stereoscope has been read to the French Academy of Sciences by M. d'Almeida. With the common instrument only one observer at a time can view the relief; *M. d'Almeida renders it visible to several at a time, and at a distance of several metres.* For this purpose he causes two stereo-

scopic images to be reflected simultaneously on a screen; as they are not identical, but only similar, the outlines of the one will intersect those of the other, and generate a confusion which can only be obviated by making each eye see only one of the images. For this purpose the inventor causes the luminous rays from each image to pass through a glass of a different colour, one red and the other green; whereby one of the images will be reflected on the screen in red, the other in green. Now, if the observer's eyes be provided with glasses of the above-mentioned colours, the eye covered with a green glass will only see the green image, while the other will only be visible to the eye protected by a red glass. The moment this is effected the relief appears, and if the observer shift his position laterally, the figure will appear to move in a contrary direction, which adds to the illusion. M. d'Almeida proposes another plan, in which both images are uncoloured, and each eye is made to perceive one image only by rapidly intercepting the other from view by means of a revolving piece of pasteboard, cut so as only to cover one of the images at a time at each half revolution. As soon as the rotatory motion acquires sufficient rapidity, the figures appear in relief.—*Times.*

THE STEREOMONOSCOPE.

M. Claudet has communicated to the Royal Society, a paper "On the Phenomenon of Relief of the Image formed on the Ground Glass of the Camera Obscura," in which he details a number of singular facts, the consideration of which led him to think that it would be possible to construct a new Stereoscope, in which the two eyes looking at a single image could see it in perfect relief, such a single image being composed of two images, of different perspectives superposed, one visible only to the right eye and the other to the left. This would be easily done by refracting a stereoscopic slide on a ground glass, through two semi-lenses separated enough to make the right picture of the slide coincide with the left picture at the focus of the semi-lenses. The whole arrangement may be easily understood: we have only to suppose that we look through a ground glass placed before an ordinary stereoscope at the distance of the focus of its semi-lenses, the slide being strongly lighted, and the eye seeing no other light than that of the picture on the ground glass; the whole being nothing more than a camera having had its lens cut in two parts, and the two halves sufficiently separated to produce at the focus the coincidence of the two opposite sides of the stereoscopic slide placed before the camera. In a paper subsequently read to the Royal Society, M. Claudet says:

This instrument, as may be perceived at once, is nothing more than an ordinary camera obscura supplied with two lenses, each mounted on a sliding frame in order to be able to give them, according to the focal distance, the horizontal separation necessary for producing on the ground glass the coalescence of the images of the two sides of a slide placed before the camera.

The slide itself being cut in two parts, the two images can also, moving in a groove, be separated in a horizontal direction, until they are sufficiently apart to be refracted on the ground glass by the two lenses in the most oblique direction consistent with the production of a well-defined image; for it is to the increased

degree of obliquity of the refracted rays in falling on the ground glass that is due the more effective extinction or evanescence of the image for the eye, whose axis consequently deviates in a greater degree from the line of refraction.

By the same principles which produce the phenomenon of relief of the image formed on the ground glass of the camera obscura, the right picture of the slide, being obliquely refracted on the ground glass by the right lens in a line coinciding with the axis of the left eye, is visible only to that eye; and the left picture, being refracted obliquely by the left lens in an opposite direction coinciding with the right eye, is only visible to that eye. Consequently each eye seeing only one image, and that image having its own perspective, the optic axes have to converge more or less according to the angular separation of the similar points of the two coincident images; and by the different degrees of convergence producing single vision of these various similar points, we have the sensation of the comparative distances of the objects represented on the ground glass.

Before having constructed this new stereoscope and tried its effect, it would have been hasty on my part to pretend that its success was certain, and for this reason I took care in my former paper to propose it as a mere speculative idea suggested by the phenomenon I had discovered, without vouching for the result. Indeed, it was not long before I had to congratulate myself on my caution, when I found that, the truth of my experiments being questioned, and the deductions from these experiments denied, my proposed stereoscope was declared impossible, as being founded on principles completely at variance with the laws of optics.

However, these remarks did not shake my conviction; and after the usual difficulties, I have now the satisfaction of being able to prove that I was perfectly right, and that I had not been led astray by any erroneous notion in my analytic and synthetic deductions. I have constructed the instrument which I propose to call the Stereomonoscope, as it exhibits in perfect relief a picture which appears single on the ground glass of the new instrument, and as single as the image of the camera obscura has always been supposed to be.

The instrument, in its present rough state, is undoubtedly very imperfect, and susceptible of many improvements which time and experience will suggest. I present it as the result of a first attempt, hoping that it will be found curious as illustrating a new and interesting scientific fact, and producing an effect quite unexpected in optics.

THE OPHTHALMOSCOPE, OR SPECULUM OCULI.

This new instrument for the exploration of the interior of the Eye has been introduced by Mr. Jabez Hogg, Assistant Surgeon to the Royal Westminster Ophthalmic Hospital, with great success. The first idea of the Ophthalmoscope was broached by Mr. Cumming, in 1846, in a paper in the Medico-Chirurgical Transactions. This attracted the attention of M. Brücke, of Vienna, who invented the instrument in 1851, which has since received its various modifications from Jaeger, Ruete, Coccius, Anagnostakis, Donders, and others. Helmholtz, it is said, founded his instrument on experiments made by Erlach with a microscope slide: it consists of reflecting pieces of glass, Dr. Ruete of Leipsic being the first to employ a concave mirror. With this instrument he investigated the internal changes of the tunics of the eye, and published in 1854 a most valuable Monograph of cases examined by him. Still, Ruete's Ophthalmoscope is rather complicated and difficult of use: he prefers for irritable and inflamed eyes the simpler forms of instruments designed by Helmholtz or Coccius; and for all purposes the concave mirror is preferable, for its facilities in the adaptation of either concave or convex lenses, of different powers, suitable to each particular case. *"The dispersion of the rays of light is greatly increased,"* observes *Ruete,* "by using the concave lens with the

mirror; and we are thus enabled to view a great portion of the back of the eye, the optic nerve, and the vessels of the retina."

"When a concave lens is used," says Mr. Hogg,* "it is as if we viewed the fundus oculi with a Galilean telescope; when two or more convex lenses, it is as if viewed through the more modern astronomical telescope.

"The Ophthalmoscope I make use of is a small circular mirror; indeed, nothing more than the silvered mirror made for an ordinary microscope, having a hole bored in its centre, and mounted in a piece of tortoiseshell. This form of instrument is generally known as M. Anagnostakis'."

The mode of using the instrument is as follows:—"The rays from the flame of the lamp, reflected by the concave mirror, fall in a state of convergence on a convex lens, in front of the eye under examination. The rays of light are so much converged by the additional refraction they undergo on entering the eye, that they quickly come to a focus, cross, and are dispersed over the retina, and thus this membrane is fully illuminated. The observer's eye looks through the small central aperture in the middle of the concave mirror, which he holds in his hand. In the examination of most eyes we find it necessary to use a bi-convex lens, of about one and a half inch focus. The rays coming from the lamp are inverted as they quit the concave mirror—an inverted image of the flame is presented to the eye—but as the rays cross behind the pupil, the image thrown upon the retina is an erect image of the flame. A convex lens held close in front of the eye observed, magnifies the erect image; but if it is moved away from the observed eye, the image on the retina is inverted. The optic nerve will now change its place, and be seen towards the temple, instead of towards the nose.

"The patient whose eye is about to be examined should be taken into a darkened room, and seated by the side of a table, on which is placed an ordinary candle, or what is better, a lamp. The lamp may be brought somewhat near to the patient's ear, and the flame so arranged that it shall keep the patient's eye in the shade, and be in a straight line with it, but lower than the eye of the observer, who is seated in front of the patient, on a stool capable of being raised. As a rule, it is better to sit a little higher than the patient. The reflecting surface of the instrument is then to be turned towards the patient's eye, in such a way that the eye of the surgeon, when looking through the small central hole, may see, upon turning the instrument a little inwards, a luminous reflection of its interior. On withdrawing it gradually, the reflection grows smaller, until it becomes oblong and very brilliant. The most conspicuous object at the fundus of the eye being the entrance of the optic nerve, this is the first point that should be sought for; and as it is situated towards the inner side, the patient must be directed to turn his eye so as to bring it directly in the line of vision. For this purpose,

* *In his Treatise* on the Ophthalmoscope. Third Edition. Published by *Churchill, New Burlington-street.*

supposing it to be the left eye that is under observation, he should be directed to look at the tip of the observer's left ear, and *vice versâ* with the right. This will generally suffice; if not, a very slight increase of obliquity to the right or left will bring it into the proper position. The ophthalmoscope may be held at first about eighteen inches distant, and slowly brought forwards until by slight movements backwards and forwards the exact focus has been obtained. If, as often happens, an image of the lamp should be formed on the lens exactly in front of the pupil, it may be got rid of by turning it slightly on its axis, either vertically or horizontally. It is in this way, or slightly modified according to circumstances, that the alterations in the several structures of the eye may be studied."

ON SOME PROPERTIES OF A SERIES OF THE POWERS OF THE SAME NUMBER.

MR. J. POPE HENNESSY, of the Inner Temple, has announced to the British Association, the discovery of some general laws which regulate the Series of the Powers of any Number. For instance, in the following series of the powers of 5, the number of digits in the several recurrent vertical series may be expressed by the powers of 2:—

Number of digits recurring.		
	5	1st.
1	25	2nd.
2	125	3rd.
	625	4th.
4	3125	5th.
8	15625	6th.
	78125	7th.
16	390625	8th.
32	1953125	9th.
	9765625	10th.
64	48828125	11th.
128	244140625	12th.
256	1220703125	13th.

—The vertical series are,

5
2
16
3580
17956240
3978175584230200.

The next consists of 32 figures, and so on. He pointed out that a similar law existed for every other number; and he exhibited formulæ by which the sum of any of the recurrent series may be determined. In the case of 5, $S_n = 2\left(S_{n-1} + 1\right)$; the consecutive sums of the several series being 7, 16, 34, 70, 142, &c. In this way tables of the powers of numbers may be constructed to any extent whatever with very little labour. This discovery will enable certain calculations to be made with a degree of accuracy hitherto impossible. The author concluded by submitting a regular demonstration *of the theorem.*

Electrical Science.

PROFESSOR FARADAY ON SCIENCE AS A BRANCH OF EDUCATION.

THE development of the applications of Physical Science in modern times has become so large, and so essential to the well-being of man, that it may justly be used, as illustrating the true character of pure science, as a department of knowledge, and the claims it may have for consideration by governments, universities, and all bodies to whom is confided the fostering care and direction of learning. As a branch of learning, men are beginning to recognise the claim of science to its own particular place;—for, though flowing in channels utterly different in their course and end to those of literature, it conduces not less as a means of instruction, to the discipline of the mind; whilst it ministers, more or less, to the wants, comforts, and proper pleasure, both mental and bodily, of every individual of every class in life. Until of late years, the education for, and recognition of it by, the bodies which may be considered as giving the general course of all education, have been chiefly directed to it only as it could serve professional services,—namely, those which are remunerated by society; but now the fitness of university degrees in science is under consideration, and many are taking a high view of it, as distinguished from literature, and think that it may well be studied for its own sake,—*i.e.*, as a proper exercise of the human intelligence, able to bring into action and development all the powers of the mind. As a branch of learning, it has (without reference to its applications) become as extensive and varied as literature; and it has this privilege, that it must ever go on increasing. Thus it becomes a duty to foster, direct, and honour it, as literature is so guided and recognised; and the duty is the more imperative, as we find by the unguided progress of science and the experience it supplies, that of those men who devote themselves to studious education, there are as many whose minds are constitutionally disposed to the studies supplied by it, as there are of others more fitted by inclination and power to pursue literature.

The value of the public recognition of science as a leading branch of education may be estimated in a very considerable degree by observation of the results of the education which it has obtained incidentally from those who, pursuing it, have educated themselves. Though men may be specially fitted by the nature of their minds for the attainment and advance of literature, science, or the fine arts, all these men, and all others, require first to be educated in that which is known in these respective mental paths; and when they go beyond this preliminary teaching, they require a self-education directed (at least in science) to the highest reasoning power of the mind.

Any part of pure science may be selected to show how much this *private self-teaching* has done, and by that to aid the present movement in favour of the recognition generally of scientific education in

an equal degree with that which is literary; but perhaps Electricity, as being the portion which has been left most to its own development, and has produced as its results the most enduring marks on the face of the globe, may be referred to.

In 1800, Volta discovered the voltaic pile, giving a source and form of electricity before unknown. It was not an accident, but resulted from his own mental self-education: it was, at first, a feeble instrument, giving feeble results; but by the united mental exertions of other men, who educated themselves through the force of thought and experiment, it has been raised up to such a degree of power as to give us light, and heat, and magnetic and chemical action, in states more exalted than those supplied by any other means. In 1819, Oersted discovered the magnetism of the electric current, and its relation to the magnetic needle; and, as an immediate consequence, other men, as Arago and Davy, instructing themselves by the partial laws and action of the bodies concerned, magnetized iron by the current. The results were so feeble at first as to be scarcely visible; but, by the exertion of self-taught men since then, they have been exalted so highly as to give us magnets of a force unimaginable in former times. In 1831, the induction of electrical currents one by another, and the evolution of electricity from magnets, was observed,—at first in results so small and feeble, that it required one much instructed in the pursuit to perceive and lay hold of them; but these feeble results, taken into the minds of men already partially educated and ever proceeding onwards in their self-education, have been so developed as to supply sources of electricity independent of the voltaic battery or the electric machine, yet having the power of both combined in a manner and degree which they, neither separate nor together, could ever have given it, and applicable to all the practical electrical purposes of life. To consider all the departments of electricity fully, would be to lose the argument for its fitness in subserving education in the vastness of its extent; and it will be better to confine the attention to one application, as the electric telegraph, and even to one small part of that application, in the present case. Thoughts of an electric telegraph came over the minds of those who had been instructed in the nature of electricity as soon as the conduction of that power with extreme swiftness through metals was known, and grew as the knowledge of that branch of science increased. The thought, as realized at the present day, includes a wonderful amount of study and development. As the end in view presented itself more and more distinctly, points at first apparently of no consequence to the knowledge of the science generally rose into an importance which obtained for them the most careful culture and examination, and the almost exclusive exercise of minds whose powers of judgment and reasoning had been raised first by general education, and who, in addition, had acquired the special kind of education which the science in its previous state could give.

Numerous and important as the points are which have been already recognised, others are continually coming into sight as the great development proceeds, and with a rapidity such as to make us believe that much as there is known to us, the unknown far exceeds it; and that, extensive as is the teaching of method, facts, and law, which can be established at present, an education looking for far greater results should be favoured and preserved. The results already obtained are so large as even in money value to be of very great importance;—as regards their higher influence upon the human mind, especially when that is considered in respect of cultivation, I trust they are, and ever will be, far greater. No intention exists here of comparing one telegraph with another, or of assigning their respective dates, merits, or special uses. Those of Mr. Wheatstone are selected for the visible illustration of a brief argument in favour of a large public recognition of scientific education, because he is a man both of science and practice, and was one of the very earliest in the field, and because certain large steps in the course of his telegraphic life will tell upon the general argument. Without referring to what he had done previously, it may be observed that, in 1840, he took out patents for electric telegraphs, which included, amongst other things, the use of the electricity from magnets at the communicator,—the dial face,—the step-by-step motion,—and the electro-magnet at the indicator. At the present time, 1858, he has taken out patents for instruments containing all these points; but these instruments are so altered and varied in character above the former, that an untaught person could not recognise them. The changes may be considered as the result of education upon the one mind which has been concerned

with them, and are to me strong illustrations of the effects which general scientific education may be expected to produce. In the first instruments, powerful magnets were used, and keepers with heavy coils associated with them. When magnetic electricity was first discovered, the signs were feeble, and the mind of the student was led to increase the results by increasing the force and size of the instruments. When the object was to obtain a current sufficient to give signals through long circuits, large apparatus were employed; but these involved the inconveniences of inertia and momentum; the keeper was not set in motion at once, nor instantly stopped; and, if connected directly with the reading indexes, these circumstances caused an occasional uncertainty of action.

Prepared by its previous education, the mind could perceive the disadvantages of these influences, and could proceed to their removal; and now a small magnet is used to send sufficient currents through 12, 20, 50, 100, or several hundred miles; a keeper and helix is associated with it, which the hand can easily put in motion; and the currents are not sent out of the indicating instrument to tell their story, until a key is depressed, and thus irregularity contingent upon first action is removed. A small magnet, ever ready for action, and never wasting, can replace the voltaic battery; if powerful agencies be required, the electro-magnet can be employed without any change in principle or telegraphic practice; and as magneto-electric currents have special advantages over voltaic currents, these are in every case retained. These advantages I consider as the results of scientific education, much of it not tutorial, but of self; but there is a special privilege about the science-branch of education—namely, that what is personal in the first instance immediately becomes an addition to the stock of scientific learning, and passes into the hands of the tutor, to be used by him in the education of others, and enable them in turn to educate themselves. How well may the young man, entering upon his duties in electricity, be taught by what is past, to watch for the smallest signs of action, new or old; to nurse them up by any means until they have gained strength; then to study their laws, to eliminate the essential conditions from the non-essential, and at last, to refine again, until the encumbering matter is as much as possible dismissed, and the power left in its highly developed and most exalted state. The alterations or successions of currents produced by the movement of the keeper at the communicator, pass along the wire to the indicator at a distance; there each one for itself confers a magnetic condition on a piece of soft iron, and renders it attractive or repulsive of small permanent magnets; and these acting in turn on a propelment, cause the index to pass at will from one letter to another on the dial face.

The first electro-magnets—*i.e.*, those made by the circulation of an electric current round a piece of soft iron—were weak; they were quickly strengthened, and it was only when they were strong that their laws and actions could be successively investigated. But now they were required small, yet potential. Then came the teaching of Ohm's law; and it was only by patient study under such teaching that Wheatstone was able so to refine the little electro-magnets at the indicator as that they should be small enough to consist with the fine work there employed, able to do their appointed work when excited in contrary directions by the brief currents flowing from the original common magnet, and unobjectionable in respect of any resistance they might offer to the transit of these tell-tale currents. These small transitory electro-magnets attract and repel certain permanent magnetic needles, and the to-and-fro motion of the latter is communicated by a propelment to the index, being there converted into a step-by-step motion. Here everything is of the finest workmanship; the propelment itself requires to be watched by a lens, if its action is to be observed; the parts never leave hold of each other; the vibratory or rotatory rachet wheel and the fixed pallets are always touching, and thus allow of no detachment or loose shake; the holes of the axes are jewelled; the moving parts are most carefully balanced,—a consequence of which is that agitation of the whole does not disturb the parts, and the telegraph works just as well when it is twisted about in the hands, or placed on board a ship or in a railway carriage, as when fixed immoveably. When it is possible, as in the vibratory needle, the moving parts are brought near to the centre of motion, that the inertia of the portion to be moved, or the momentum of that to be stopped, should be as small as possible, and thus great quickness of indication obtained. All this delicacy of arrangement and workmanship is introduced advisedly; for the inventor, whom I may call the student here, considers that refined and perfect workmanship is more exact in its action, more unchangeable by time and use, and more enduring in its existence, than that which being heavier must be coarser in its work.

manship, less regular in its action, and less fitted for the application of force by fine electric currents. Now there was no accident in the course of these developments;—if there were experiments, they were directed by the previously acquired knowledge;—every part of the investigations was made and guided by the instructed mind.

The results being such (and like illustrations might be drawn from other men's telegraphs, or from other departments of electrical science), then, if the term education may be understood in so large a sense as to include all that belongs to the improvement of the mind either by the acquisition of the knowledge of others or by increase of it through its own exertions, we learn by them what is the kind of education science offers to man. It teaches us to be *neglectful* of nothing;—not to despise the small beginnings, for they precede of necessity all great things in the knowledge of science, either pure or applied. It teaches a continual comparison of the *small and great*, and that under differences almost approaching the infinite: for the small as often contains the great in principle as the great does the small; and thus the mind becomes comprehensive. It teaches to deduce principles carefully, to hold them firmly, or to suspend the judgment:—to discover and obey *law*, and by it to be bold in applying to the greatest what we know of the smallest. It teaches us first by tutors and books to learn that which is already known to others, and then by the light and methods which belong to science to learn for ourselves and for others;—so making a fruitful return to man in the future for that which we have obtained from the men of the past. Bacon, in his instruction, tells us that the scientific student ought not to be as the ant who gathers merely, nor as the spider who spins from her own bowels, but rather as the bee, who both gathers and produces. All this is true of the teaching afforded by any part of physical science. Electricity is often called wonderful—beautiful;—but it is so only in common with the other forces of nature. The beauty of electricity, or of any other force, is not that the power is mysterious and unexpected, touching every sense at unawares in turn, but that it is under *law*, and that the taught intellect can even now govern it largely. The human mind is placed above, not beneath it; and it is in such a point of view that the mental education afforded by science is rendered supereminent in dignity, in practical application, and utility; for, by enabling the mind to apply the natural power through law, it conveys the gifts of God to man.

STATIC INDUCTION.

PROFESSOR FARADAY has read to the Royal Institution—the Prince Consort, Vice-Patron, in the chair—"Remarks on Static Induction." After referring to the simple case of evolution of electricity by the friction of flannel and shell-lac, and tracing the effect upon their separation into ordinary cases of induction, and after calling attention to induction, as action at a distance, and through the intervening matter, Professor Faraday proceeded to examine closely the means by which the state of the intervening substance would be truly ascertained, choosing sulphur as the body, because of its admirable non-conducting conditions and its high

specific inducting capacity. It is almost impossible to take a block of sulphur out of paper, or from off the table, without finding it electric; if, however, a small spirit-lamp flame be moved for a moment before its surface at about an inch distance, it will discharge it perfectly. Being then laid on the cap of the electrometer, it will probably not cause divergence of the gold-leaves; but the proof that it is in no way excited is not quite secure until a piece of uninsulated tinfoil or metal has been laid loosely on the upper surface. If there be any induction across the sulphur, due to the feeble excitement of the surfaces by opposite electricities, such a process will reveal it: a second application of the flame will remove it entirely. When a plate of sulphur is excited on one side only, its application to the electrometer does not tell at once which is the excited side. With either face upon the cap the charge will be of the same kind, but with the excited side downwards the divergence will be much, and the application of the uninsulated tinfoil to the top surface will cause a moderate diminution, which will return as the tinfoil is removed; whereas, with the excited side upwards, the first divergence of the leaves will be less, and the application of the tinfoil on the top will cause considerable diminution. The approximation of the flame towards the excited side will discharge it entirely. The application near the unexcited side will also seem partly to discharge it, for the effect on the electrometer will be greatly lessened; but the fact is, that the flame will have charged the second surface with the *contrary* electricity. When, therefore, the originally excited surface is laid down upon the cap of the electrometer, a diminished divergence will be obtained, and it is only by the after-application of uninsulated tinfoil upon the upper surface that the full divergence due to the lower surface is obtained.

Being aware of these points, which are necessary to safe manipulation, and proceeding to work with a plate of sulphur in the field of induction before described, the following results are obtained:—A piece of uncharged sulphur being placed in the induction field, perpendicular to the lines of inductive fire, and retained there, even for several minutes, provided all be dry and free from dust and small particles, when taken out and examined by the electrometer, either without or with the application of the superposed tinfoil, is found without any charge. A gilt plate carrier, if introduced in the same position and then withdrawn, is found entirely free of charge. If the sulphur plate be in place, and then the carrier be introduced and made to touch the face of the sulphur, then separated a small space from it, and brought away and examined, it is found without any charge; and that whether applied to either one side or the other of the block of sulphur. So that any of these bodies, which may have been thrown into a polarized or peculiar position whilst under induction, must have lost that state entirely when removed from the induction, and have resumed their natural condition.

Assuming, however, that the sulphur had become electrically *polarized in the* direction of the lines of induction, and that therefore *whilst in the* field one face was positive and the other negative, *the mere touching* of two or three points by the gold-leaf carrier

would be utterly inefficient in bringing any sensible portion of this charge or state away; for though metal can come into *conduction contact* with the surface particles of a mass of insulating matter, and can take up the state of that surface, it is only by real contact that this can be done. Therefore the two sides of a block of sulphur were gilt by the application of gold-leaf on a thin layer of varnish, and when the varnish was quite dry and hard, this block was experimented with. Being introduced into the induction field for a time and then brought away, it was found free from charge on both its surfaces; being again introduced, and the carrier placed near to it, but not touching, the carrier, when brought away, showed no trace of electricity. The carrier being again introduced at the side, where the charged or inductric body (made negative) is placed, made to touch the gilt surface of the sulphur on that side, separated a little way, and then brought out to be examined, gave a positive charge to the electrometer; when it was taken to the other side of the sulphur and applied in the same manner, it brought away a negative charge. Thus showing that whilst the sulphur was under induction, the side of it towards the negative inductric was in the positive state, and the outer side in the negative state.

Thus the di-electric sulphur, whilst under induction, is in a constrained polar electrical state, from which it *instantly* falls into an indifferent or natural condition the moment the induction ceases. That this return action is due to an electrical tension *within* the mass, sustained while the act of induction continues, is evident by this, that if the carrier be applied two or three times alternately to the two faces, so as to discharge in part the electricity they show under the induction, then on removing the sulphur from the induction field it returns, not merely to neutrality or indifference, but the surfaces assume the opposite states to what they had before; a necessary consequence of the return of the mass of inner particles to or towards their original condition. The same result may be obtained, though not so perfectly, without the use of any coatings. Having the uncoated sulphur in its place, put the small spirit-lamp on the side way from the negative inductric; bring the latter up to its place, remove the spirit-lamp flame, and then the inductric body, and finally, examine the sulphur; the surface towards the flame, and *that only*, will be charged—its state will be found to be positive, just like the same side of the gilt sulphur which had been touched two or three times by the carrier. During the induction, the mass of the sulphur had been polarized; the anterior face had become positive, the posterior had become negative; the flame had discharged the negative state of the latter; and then, on relieving the sulphur from the induction, the return of the polarity to the normal condition had also returned the anterior face to its proper and unchanged state, but had caused the other, which had been discharged of its temporary negative state whilst under induction, now to assume the positive condition. It would be of no use trying the flame on the *other side of the* sulphur plate, as then its action would *be to discharge the* dominant body, and destroy the induction

altogether. When several plates were placed in the inductive field apart from each other, subject to one common act of induction, and examined in the same manner, each was found to have the same state as the single plate described. It is well known that if several metallic plates were hung up in like manner, the same results would be obtained.

From these and such experiments the speaker took occasion to support that view of induction which he put forth twenty years ago, (*Phil. Trans.* 1837,) which consists in viewing insulators as aggregates of particles, each of which conducts within itself, but does not conduct to its neighbours, and induction as the polarization of all those particles concerned in the electric relation of the inductric and inducteous surfaces: and stated that, as yet, he had not found any facts opposed to that view. He referred to specific inductive capacity, now so singularly confirmed by researches into the action of submarine electro-telegraphic cables, as confirming these views; and also to the analogy of the tourmaline, whilst rising and falling in temperature, to a bar of solid insulating matter, passing into and out of the inductive state.

Professor Faraday has made the following addition to the above Report:—

The inquiries made by some who wish to understand the real force of the test experiments relating to static induction, and their consequences in relation to the theory of induction, make me aware that it is necessary to mention certain precautions which I concluded would occur to all interested in the matter; I hope the notice I propose to give here will be sufficient. When metallic coatings or carriers are employed for the purpose of obtaining a knowledge of the state of a layer of insulating particles, as those forming the surface of a plate of sulphur, it is very necessary that they should exist in a plane perpendicular to the lines of the inductive force, and in a field of action where the lines of force are sensibly equal. Hence the importance of the dimensions given in the description of the apparatus at page 3 of the Report of the evening, where the inductive surfaces are described as nine inches in diameter, and nine inches apart. The inductive surface there mentioned is a plane: a ball cannot properly be used for this purpose; for the lines of inductive force originating at it cannot then be perpendicular to the layer of gold-leaf forming the coating of the sulphur. The consequence would be, that this layer of gold being virtually extended along the lines of inductive force—*i.e.*, having parts nearer to and parts more distant from the inductric—will be polarized according to well-known electrical actions, will have opposite states at those parts, will show these states by a carrier, and will give results not belonging merely to insulating particles in a section across the lines, but chiefly to united conducting particles in a section oblique to or along the lines. The carrier itself must be perfectly insulated the whole time, or else a case of induction, not including the sulphur, and entirely different to that set out with, is established. It must not even extend by elongation into parts of the field of induction where the force differs in degree, or else errors of the same kind as those described with the ball inductric will occur. It should also be so used as to receive no charge by convection. When introduced between the inductric and the sulphur, it is very apt, if the charge be high, or if particles adhere to the inductric, to receive a charge. This is easily tested by introducing the carrier into its place, abstaining from touching the gold-leaf, withdrawing the carrier, and examining it: it is not until this can be done without bringing away any charge that the carrier should be employed to touch the gold-leaf surface, and bring away the indication of its electrical state. As before said, if when the state of matters is perfect, and *no convection interferes*, the gilt sulphur be put into its place, left there for a *short time, and brought away again*, it will be found without any charge either of *the gold-leaf coating* or the sulphur. If it be put into place, the coating next the

inductric be uninsulated for a moment only, and the plate brought away, that coating will then appear positive. If it be put into place, and the further gold-leaf be uninsulated for a moment, that coating when the plate is brought away will be found negative. These are all well-known results, and will always appear if convection and other sources of error be avoided.

RÜHMKORFF'S INDUCTION COIL.

MR. W. LADD has communicated to the British Association, a paper "On a Modification of Rühmkorff's Induction Coil." Having been rather extensively engaged for the last two years in the manufacture of Induction Coils, and having received the constant and able advice of Mr. J. P. Gassiot, and the practical suggestions of Mr. C. A. Bentley, (says Mr. Ladd,) I have thought that a brief description of the machine as it is now made, with the results obtained, may not be uninteresting. My object has been not to make very large machines, but to obtain the greatest results from a three-mile coil, that being sufficiently large for all ordinary purposes. I find the best length for the iron core to be 13 inches and about 15·8 diameter, composed of fine iron wire not larger than No. 22, very carefully annealed. The primary wire should be of sufficient size to carry freely the whole of the battery current, and of sufficient quantity to thoroughly saturate the iron core with magnetism. For this purpose I use three layers of one continuous No. 12 copper wire carefully annealed : if more layers are used, I find that the secondary wire is removed too far from the magnetic influence. The secondary wire ought not to be larger than No. 35, covered with silk, which must be laid on perfectly even, and insulated from the primary wire, and also from the layers of the secondary next to it. I find the best insulating medium to be the thinnest gutta percha made, and which I believe to be the only gutta percha sold which cannot be adulterated; it is true that it has many minute perforations, but by laying on at least six thicknesses between each layer of wire perfect insulation is secured. The greatest care must be taken in protecting the ends of the layers, so as to prevent the sparks passing from one to the other. The condenser should be at least 50 sheets of tinfoil, of about 1 square foot in size. These sheets must be separated from each other by three sheets of varnished paper, or gutta percha tissue. Every alternate sheet of foil is connected together, thus forming two poles, to be attached one to each side of the break. It may be placed at the bottom of the stand or in a separate box ; the latter I prefer. In developing the power of the machine, everything depends upon the contact-breaker, which should be capable of retaining contact until the whole of the magnetism is obtained, and capable also of breaking contact as soon as the smallest quantity is induced. *These results are obtained in the break attached to this instrument.* The hammer is made to vibrate freely between the iron core and the coil, and the brass screw terminating with the platina plate at the back of the hammer : a very small amount of magnetism will be sufficient to attract the hammer and so break the contact. If now I *bring this screw (placed half-way* up the spring carrying the hammer)

to bear upon the spring, it will have the effect of pressing the two platina plates together, so that it takes a greater amount of magnetism to separate them. By this means I can regulate the power of the instrument to the purposes for which it is required. The battery I employ is a five cells of "Grove's," with immersed platina plates 5 + 3, having an exposed surface of 140 square inches. With such a battery and a coil thus constructed, I can always ensure sparks from half an inch to four inches in air. The machine now exhibited contains six miles of wire, and worked with the same battery, gives 6¼ inch sparks. The position which the induction coil is now taking in this electrical age is one of considerable importance. It has awakened new philosophical ideas, and is being successfully applied to practical purposes of the highest advantage to mankind. For blasting purposes a three-mile coil is capable of firing fifty charges simultaneously. But important as its present position is, and successful as its past application has been, it is yet in its infancy; and there can be little doubt that by *patient perseverance* machines can be constructed that will obviate the necessity for employing such ponderous machines, and still more ponderous batteries, as are now at work on the Atlantic Cable.—*Athenæum*, No. 1615.

ELECTRICAL DISCHARGES.

A PAPER has been read to the British Association, "On the Phosphorescent Appearance of Electrical Discharges in a Vacuum made in Flint and Potash Glass," by Mr. J. P. Gassiot. The discharge from an induction coil when taken in a vacuum tube made of flint glass, has (under certain conditions) the property of rendering the glass highly phosphorescent, the phosphorescence being denoted by the intense blue colour of the glass with which the stratifications are surrounded. On trying the discharge in some vacuum tubes I had obtained from M. Geissler, of Bonn, I observed that the phosphorescence was no longer blue, but was of a slight green colour. To test whether this difference was due to the gaseous matter remaining in Geissler's tubes, or to the character of the glass which he uses, I had Torricellian vacuums prepared in German glass tubes, and in this manner ascertained that the difference in the colour was entirely due to the character of the glass: that of Germany is, I believe, made with potash, and is entirely free from any lead, while in the English flint glass lead is introduced to some extent. I have recently obtained a vacuum tube from Bonn, which shows this difference in a very beautiful manner: the outer ends of the tube are composed of German glass, the centre of the tube is of English glass; by this arrangement the contrast between the two is very manifest.

Next was read a paper "On Induced Electrical Discharges when taken in Aqueous Vapour," by Mr. J. P. Gassiot, who said: "If the tube of a well-constructed water-hammer is partly covered with two separate coatings of tinfoil, the coatings are connected one with the outer, and the other with the inner terminal of an induction coil, a

discharge will be observable through the centre of the tube in the form of a wave line. On repeating this experiment I ascertained that the vacuum in the tube was very much deteriorated. I could no longer produce that peculiar bubbling in the ball of the apparatus which is always attainable by gently heating the tube with the warmth of the hand; this bubbling was originally very sensibly perceptible in the tube I now exhibit when I first received it from the maker, Mr. Casella. I have repeated the experiment with other water hammers, and always with the same result; but I have not yet opened one to examine whether the vapour has been decomposed, and gas evolved."

At the close of the reading of these experiments the room was darkened, and Mr. Ladd and Mr. Gassiot exhibited the several experiments described in the paper, which were very vivid and strikingly beautiful.

The President, when returning the thanks of the Section to Mr. Gassiot and Mr. Ladd, after some highly complimentary observations regarding the munificent exertions of Mr. Gassiot in the cause of science, said he expressed the wish of the gentlemen more immediately around him, and he had no doubt of the Section at large, that these gentlemen would consent to repeat those very beautiful and brilliant experiments in a more convenient room than the one that had been allotted to Section A, at one of the evening meetings, when a larger number of the members of the Association than those who had witnessed them to-day might be gratified with their exhibition. This Mr. Gassiot consented to do, if the requisite arrangements were made by the local officers.

We quote the above from the able Report of the Meeting of the British Association, in the *Athenæum*, No. 1516.

THE ELECTRIC SILURE.

In the *Year-Book of Facts*, 1857, p. 224, and the *Year-Book*, 1858, p. 151, we described the new Electric Fish from Old Calabar, named the *Malapterurus Beninensis*, of which three living specimens have been brought to Edinburgh, one of which has been conveyed to Berlin, and there placed at the disposal of Professor J. Müller.

With this fish, M. du Bois-Reymond has made some remarkable experiments. The fish is the most lively of the three: it measures six inches in length. The most important point was to ascertain the distribution of the electric tensions, which is still unknown. According to the concurrent statements of many observers, at the moment of the shock in the *Torpedo*, the dorsal surface of the organ is positive, and the ventral surface negative; that is to say, the current passes in the organ from the belly to the back, and in the surrounding water, or a curved conductor applied to the two surfaces, from the back to the belly.

Of the *Malapterurus* of the Nile, we have recently had a description elaborated with all the modern aids, by M. Bilharz, a German naturalist living *in Cairo*; so that in a morphological point of view, *this is, perhaps, the best* known of all electromotive fish. By the

introduction of the idea of the *electrical plate*, M. Bilharz has, in all probability, secured the credit of having first attained to a clear view of the essential structure of an electrical organ. In a physiological point of view, on the other hand, nothing more was hitherto known of the *Malapterurus* than what was known to Adanson, no less than 106 years ago, namely, that it gives an electrical shock.

M. Bilharz has endeavoured to come to a conclusion as to the distribution of the tension occurring in the organ of the *Malapterurus* from anatomical grounds.

Thus, Pacini's *prolungamenti spinaformi* on the hinder negative surface of the electrical plates of the organ of *Gymnotus* are regarded by M. Bilharz with great probability as nerve-tubes, which immerse themselves in the plates. In the *Torpedo*, the nerves would also pass to the lower negative surface of that structure which is indicated by M. Bilharz as the electrical plate. Now, as in the organ of the *Malapterurus*, the nerve-tubes pass to the hinder surface of the electrical plates, Bilharz concludes that in this fish, as in the *Gymnotus*, the head end is positive, and the tail end negative, so that the current in the organ will be directed from the tail to the head.

Thus great interest is now attached to the exact examination of the shock of the *Malapterurus*. The experiments were made in the presence of MM. Goodsir, J. Müller, G. Wagener, and Paul du Bois-Reymond. The fish was placed in a shallow cylindrical glass jar of about six inches in diameter, which was filled with water to a depth of nearly two inches. For conducting the current, two metallic saddles were placed upon the fish,—the same process as that adopted by Faraday with the *Gymnotus*. They consisted of strips of strong platinum-foil, 5 millims. in breadth, bent into the form of the transverse section of the fish, and were 55 millims. in length for the thick anterior part, and 45 millims. in length for the thinner caudal extremity. To these strips copper wires coated with gutta-percha were soldered, serving as insulating handles; the soldered parts were carefully covered with varnish. The wires were connected with the ends of a multiplier of 550 convolutions, with heavy double needles. The platinum saddles in Spree water produced no effect upon this multiplier. Lastly, in accordance with Galvani's arrangement for the *Torpedo*, a prepared frog was so placed upon the edges of the glass jar, that it could not but betray by its convulsions every discharge of the fish.

When the saddles were placed upon the head and tail of the fish, the frog was convulsed, and the needle flew round the dial in a direction which indicated *the head to be negative and the tail positive, or a current in the organ from the head to the tail, and in the surrounding water and the wire of the multiplier from the tail to the head.* The experiment was repeated again with the same result. The magnetism of the needles had undergone no perceptible alteration.

M. Bilharz's prediction consequently has not proved true. The *current in the Malapterurus* has a direction opposite to that in the *Gymnotus*. *If* a pile of the organ of the Torpedo, in order to become

one of the organ of the *Gymnotus*, must bend forwards with its upper end, in order to become a column of the organ of the *Malapterurus*, it must lean the same end backwards.—*Phil. Mag.*, No. 97, *abridged.*

ELECTRICAL PHENOMENA IN NEW YORK AND OHIO.

THERE has been read to the American Association at Baltimore, a paper "On some Electrical Phenomena witnessed in houses in the cities of New York and Cleveland, Ohio," by Professor St. John.*

By invitation of Professor Loomis, of the New York University, (says Professor St. John,) I accompanied him on the evening of the 12th of February, 1858, to witness some experiments on electricity, exhibited in a house in Fourteenth-street, in the city of New York. The rooms in which the experiments were performed had upon the floors thick velvet carpets, and the usual furniture of elegant houses; they are warmed by furnaces, and are kept at a nearly uniform temperature of 70° F. The experiments were performed by the gentleman and lady of the house, and Professor Loomis, who had put on dry slippers. After walking rapidly through the parlours with a shuffling motion, very bright electrical sparks were exhibited when the hand was presented to the chandeliers or other good conductors communicating with the ground. Gas was ignited at one of the burners by a spark from a key in the hand of the lady, and sulphuric ether inflamed by the spark passing from her finger to the liquid which I held in a metallic cup in electrical connexion with the earth. The spark was made to pass between two small insulated brass balls, with a view to measure its length. The greatest length attained was one-fourth of an inch. The spark exhibited a beautiful appearance in a darkened room when the fingers were brought near to the wall-paper, dispersing itself through the space of a foot or more over the gilded ornaments of the paper. On the evening of the 5th of March, the coldest day of the season, the experiments were repeated in the same rooms, when a sensible increase of electrical intensity was discerned. The gas and ether were inflamed by Professor Loomis holding a brass ball in his hand, and the length of the spark attained was a little more than one-third of an inch.

These phenomena were similar to such as I often witnessed during the winters of 1854-5 at the Cleveland Female Seminary, located in the south-east quarter of the city of Cleveland, Ohio. The building is three stories high, of brick, with a sandstone basement, and is warmed by three furnaces supplied with the ordinary bituminous coal of south-eastern Ohio, the fires declining, but not becoming extinct during the night. The temperature of the rooms varied considerably, sometimes rising above 80°, but rarely falling below 60° even during the night. The rooms in which the electrical manifestations were conspicuous were the parlours on the first floor above the basement. The floors of these rooms were covered with substantial Brussels carpets. The seasons when they attracted especial atten-

* *See also the Paper read to* the British Association in 1857, by Prof. Loomis *Year-Book of Facts, 1858, p. 147.*

tion were periods of severely cold weather—the thermometer on one occasion indicating 23° below zero; the electrical excitement diminished in mild weather, and ceased entirely when it rained. The carpets on the halls and other rooms were thinner fabrics than Brussels carpeting, or composed partly of cotton or linen, and upon these the electrical phenomena were barely discernible. In the parlours, electricity was manifested during dry cold weather at all hours of the day, but much more strikingly in the evening, after the young ladies had spent an hour in recreation and dancing. On such occasions the intensity of the spark was such as readily inflamed ether and pulverized resin, and measured repeatedly one-half inch, passing between insulated balls to the furnace register, which was in good electrical communication with the earth. All persons remaining in the rooms were enabled to communicate sparks to conductors, but the longest sparks were given by two boys of the ages of nine and eleven years, after running and sliding upon the carpets; this we attributed to the friction evolved by their unconstrained freedom of motion. These boys wore dry slippers, were clad in woollen, one of them wearing flannel next to his person, and the other cotton; the latter, who was of more vigorous constitution and active habits, giving the more vivid spark. A difference of electrical accumulation was also discernible among the young ladies, which we were inclined to ascribe to diversities in their dress, silk, woollen, cotton—the silk and woollen appearing more favourable to success. In one instance the different degrees of moisture upon the skin seemed to affect the amount of electricity communicated. These phenomena attracted the attention of all the inmates and visitors of the seminary; many persons expressing surprise, and some consternation, on receiving a shock, as they entered the room and took the hand presented to welcome them, preceded by a vivid spark. The passage of the spark over glass by bits of tinfoil disposed in letters, and in the "spiral tube," together with the usual experiments on electric light, were repeatedly exhibited as a source of amusement.

ROTATION PRODUCED BY ELECTRICITY.

THERE has been exhibited to the Royal Society, an apparatus displaying the Rotation of a Metallic Sphere by Electricity. It was contrived by Mr. Gore, of Birmingham, who states that his experiments had their origin in a phenomenon observed by Mr. Fearn, of Birmingham, in his electro-gilding establishment—that a tube of brass half-an-inch in diameter and 4 feet long, placed upon two horizontal and parallel brass tubes, 1 inch in diameter and 9 feet long, and at right angles to them, and the latter connected with a strong voltaic battery consisting of from 2 to 20 pairs of large zinc and carbon elements, the transverse tube immediately began to vibrate, and, finally, to roll upon the others. Acting upon this, Mr. Gore constructed a disc of wood provided with two brass rails, level, uniform, and equidistant; on these rails a hollow and very thin copper ball was placed, and, the brass rails being connected with a zinc and carbon battery, the ball began to vibrate, and presently to

revolve. In all cases yet observed, Mr. Gore states that the motion of the ball is attended by a peculiar crackling sound at the points of contact, and by heating of the rolling metal. When the apparatus was exhibited before the Royal Society, electric sparks were seen as the ball rolled from the spectator.—*Athenæum.*

ELECTRICITY IN TOOTH EXTRACTING.

Mr. Kennely Bridgeman, of Norwich, in a letter to the *Times*, thus describes the *modus operandi* of this new application of Electricity for producing local anæsthesia in Tooth-drawing, stated to be an American discovery.

The apparatus for the purpose is extremely simple, and consists principally of the common electro-magnetic machine used in medical electricity; a single cell and pair of plates constituting a Smee's battery, and a small electro-magnetic coil with a bundle of wires for graduating the strength of the current. One end of the thin wire conveying the secondary current is attached to the handle of the forceps, and the other end of it to a metallic handle to be placed in the hand of the patient. The instrument touching the tooth completes the circuit, and the current passes instantaneously.

The wire attached to the forceps should be made to pass through an interrupting footboard, so that the continuity of the wire may be made or broken in an instant by a movement of the right foot of the operator. The advantage of this arrangement is that it allows the instrument to be placed in the mouth without risk of producing a shock in coming in contact with the lips, cheeks, or the tongue, which would interfere with the quiet of the patient.

A hole drilled in the end of the left handle of the forceps and the end of the wire tapered to fit rather tightly allows the substitution of one pair of forceps for another with scarcely a moment's delay.

A Meeting of the College of Dentists has been held with a view to raise a discussion upon the important question of electricity as an anæsthetic agent. Mr. Peter Matthews, the President of the Society, who filled the chair, passed in review the various methods by which electricity might be applied, with the intention of rendering the extraction of teeth painless; but, unhappily, the results of his experience did not warrant him in stating that so desirable a condition had as yet been attained. On the contrary, he believed that the attention being arrested and the mind occupied during the application of anything so novel as electricity would sufficiently explain the power which that agent apparently possessed occasionally to somewhat mitigate pain. Several other gentlemen corroborated this conclusion by the results of their individual experience; but the subject was opened to further inquiry, and Dr. Elliotson moved that a committee be formed for that purpose.

MEDICAL GALVANIC CHAINS.

Mr. *Pulvermacher*, of Oxford-street, has patented certain *improvements in these articles*, his object being to produce constant

batteries with the aid of a single exciting liquid. His new invention consists—

1. In an arrangement of electro-magnetic apparatus for producing induced currents. Inside the coil of copper wires he carries down numerous small iron wires, and bends them up back again to the top of the apparatus, one-half over the outside of the coil of copper wire on one side, and the other half outside the coil on the opposite side, and then unites them to a bar of soft iron, the outer ends of which are connected to coil springs outside the apparatus, in order that to and fro motion of the bar may be obtained by the interruption of the circuit.

2. He produces a constant and energetic current in batteries without the employment of any acid by the use of positive metal—for instance, zinc, and carbon, or other negative body, and a solution of bichromate of potassa, bisulphate of potassa, and sea salt. And he finds it very advantageous to construct batteries in such manner that the atmospheric air may act upon the metal and exciting liquid simultaneously. For portable flexible batteries he takes a foundation of gutta percha, in the form of a strip or band, and perforates it at intervals of, say half an inch; he then winds wires around it into separate elements, and unites the whole into one battery. Or he weaves copper and zinc wires with a non-metallic or textile warp, divides the fabric thus composed into separate elements, and unites the whole to form a battery. Or he prints upon a textile material with an adhesive composition, and covers it with metal leaf or foil, or powders thereon metal in filings or powder, and, by pressure, obtains a metal surface.

He next prints a corresponding form in adhesive composition, and covers it with metal leaf or foil, or powders it over with metal electrically positive or negative to that previously mentioned, and by pressure obtains a metal surface. Or he takes a positive metal, say zinc plate, and forms parallel slits therein, and presses out every piece between two slits on one side and then on the other side alternately, whereby a cage or holder is formed; he then inserts a small and negative plate, say copper, similarly formed, but smaller, to allow of the pieces of copper coming into the spaces between the pieces of zinc without touching them; he thus obtains a large surface in a very small compass. These batteries may be excited by being dipped in an exciting liquid and then withdrawn, or by being supplied by capillary attraction through some porous body.—*Mechanics' Magazine*, No. 1819.

MUSIC BY ELECTRICITY.

A HUNGARIAN, M. Leon Humar, according to the Brussels *Emancipation*, has played at a public concert in the National Theatre, by means of electric wires, on five different pianos at the same time. The battery which worked the wires was in an adjacent room. A correspondent had previously pointed out the feasibility of such an arrangement, in the *Mechanics' Magazine* for June, 1858.

IMPROVED ELECTRIC LAMP.

Dr. Macadam has described to the British Association this invention by Mr. W. Hart, Edinburgh. Its chief peculiarity consists in its having an electro-magnet, which regulates the distance between the charcoal points, in proportion to the electrical current. Professor Faraday objected to the construction of the lamp, and said, the great requisite in electric lamps was a regulator, independent of the hand, to keep the charcoal points the proper distance from each other.

ELECTRO DEPOSITING.

Under patented processes, Messrs. Schaub and Godfrey have applied Electro Depositing to the production of relief-letters, figures, and ornaments for inscriptions, for plates with inscriptions, and detached and open ornaments for ornamenting book-covers, wood, papier-mâché, and other furniture. Advantage is taken of the truthful copying by engraving fine outlines in the originals to indicate colour ornamenting; and in this way it is made easy, even to children, to shade and decorate the letters and ornaments correctly. In open-work, such as book-corners and centres, panels for brooches, mats, designs, and ornaments are produced at so low a price, that they can compete even in respect to prices with the inferior stamped work that we have been accustomed to see.—*Builder*, No. 829.

PROGRESS OF ELECTRICITY AND MAGNETISM—NEURO-ELECTRICITY.

Professor Owen, in his Address to the British Association, observed: My estimable predecessor adverted last year to the fact that it was in the committee-rooms of the British Association that the first step was taken towards that great magnetic organization which has since borne so much fruit. Thereby it has been determined that there are periodical changes of the magnetic elements depending on the hour of the day, the season of the year, and on intervals of about ten years. Also, that besides these regular changes there were others of a more abrupt and seemingly irregular character—Humboldt's "magnetic storms"—which occur simultaneously at distant parts of the earth's surface. Major-General Sabine, than whom no one has done more in this field of research since Halley first attempted "to explain the change in the variation of the magnetic needle," has proved that the magnetic storms also observe diurnal, annual, and undecennial periods. But with what phase or phenomenon of earthly or heavenly bodies, it may be asked, has the magnetic period of ten years to do? The coincidence which points to, if it does not give the answer, is one of the most remarkable, unexpected, and encouraging to patient observers. For thirty years a German astronomer, Schwabe, had set himself the task of daily observing and recording the appearance of the sun's disc; in which time he found that the spots passed through periodic phases of increase and decrease, the length of the period being about ten years. A comparison of *the independent* evidence of the astronomer and magnetic *observer has shown that* the decennial magnetic period coincides

both in its duration and in its epochs of *maximum* and *minimum* with the same period observed in the solar spots. After referring to some further steps in this science, Professor Owen said the generalization was established, and with a rapidity unexampled, regard being had to its greatness, that magnetism and electricity are but different effects of one common cause. This has proved the first step to still grander abstractions, to that which conceives the reduction of all the species of imponderable fluids of the chymistry of our student days, together with gravitation, chymicity, and neuricity, to interchangeable modes of action of one and the same all-pervading life-essence. Referring to the experiments of Galvani and Volta, and what had subsequently been done in the same line, the Professor continued—From the present state of neuro-electricity it may be concluded that nerve force is not identical with electric force, but that it may be another mode of motion of the same common force; it is certainly a polar force, and, perhaps, the highest form of polar force:—

> "A motion which may change, but cannot die;
> An image of some bright eternity."

THE ELECTRIC LIGHT.

Dr. Watson, of the Electric Power Light and Colour Company (following a hint by the Editor of the *Builder*), has entered into arrangements with the Government authorities for applying this novel agency in aid of the operations now in progress for the erection of the new bridge at Westminster. The advancement of the works being contingent on the state of the tide, they have consequently often to be prosecuted after dark; and hence the importance of pressing any improved lighting appliance afforded by scientific discovery into the service of such an enterprise. In the first experiment the lighting apparatus used, which was computed to possess illuminating power equal to that of 72 Argand burners, or of nearly 1000 wax-candles, was stationed on the river's brink, so as to throw its rays upon a working stage fixed some 200 feet or upwards out into the stream, and upon which, it being low tide at the time, a body of workmen, 45 in number, were engaged in pile-driving by means of eight ponderous "monkey" hammers. Chappuis's reflector was used on the occasion; and the electric battery for supplying the necessary power, and which was fitted with six dozen cells, was posted on the Middlesex shore, or at a distance of 2000 feet. The experiment proved eminently successful. The light diffused over the working stage was of an intense and yet agreeable brilliancy, far exceeding the lustre of the brightest moonlight, but resembling the moon's mild radiance. It should be added that the new light was subject to a transient and occasional flickering, but it was so slight as not to cause the least perceptible inconvenience to the men: and, besides this defect, which is traceable to the fluctuation of the electrical power, is considered to be inseparable from the operation of so subtle an agent. The light appeared to be fully as manageable as gas, to extinguish it or turn it on being but the work

of a moment. Dr. Watson undertakes to furnish this light at the lowest cost of gas, his great gain being ensured from his mode of utilizing the residuary products of the battery in making colours.

OVERHOUSE TELEGRAPHS.

THIS domestic application of the Electric Telegraph has already been noticed in the *Year-Book of Facts*, 1858, and Messrs. Waterlow's introduction of it recorded; their three places of business communicating with each other by electric means. The line of wires (double) commences at London-wall, proceeding direct to Birchin-lane, and thence, supported at different intervals, terminates in Parliament-street. The distances and intervals of support are as follows :—

	Feet.
1. From London-wall to Birchin-lane	1500
2. Birchin-lane to Sterry's in Cannon-street . . .	900
3. Sterry's to Calvert's Brewery, Upper Thames-street .	900
4. Calvert's to Red Lion Wharf, Upper Thames-street .	900
5. Red Lion Wharf to Maidstone Wharf, Queenhithe .	840
6. Maidstone Wharf to Trigg Wharf, Upper Thames-street	1050
7. Trigg Wharf to Ponsford's City Mills	960
8. City Mills, crossing the river, to Glass Warehouse (Surrey side)	1380
9. Glass Warehouse to White's Iron Wharf. . . .	750
10. White's to Burr's Shot Tower	1200
11. Shot Tower to Goding's Brewery	1200
12. Brewery to Maudslay's	1569
13. Maudslay's, crossing the river, to Parliament-street .	1535

The wires are supported on poles fixed to the tops of the houses at such convenient distances as are most readily obtainable, and Mr. Waterlow has, for this purpose, used a kind of saddle, in cast iron, carrying a socket into which the supporting pole is fixed. The saddle fits on the ridge of the house, and is held in its place by two screws into the ridge-tree and four into the rafters. The pole is kept steady and firm by means of guy wires from its extremity to the roof. No injury whatever is done to the house by the fixing of the supports. Six screws only are used, and when removed, all that has to be done is to fill up and make good the holes from whence they are withdrawn. The telegraph wires are No. 14 gauge, and are of steel, but little larger than common bell-wire, thus combining strength with lightness. It might have been imagined that difficulty would occur in obtaining the assent of the various proprietors of house property over which the wires pass, but Mr. Waterlow has rarely met with any difficulty from them; on the contrary, with some unimportant exceptions, he has received every facility for carrying his object into effect. Mr. Waterlow states the cost to be at the rate of 50*l.* per mile, including poles, wires (double line), insulators, labour, and everything except the instruments, the whole fixed and painted with three coats of paint in oil. Mr. Waterlow has adopted a very novel and ingenious mode by which the wires can be painted, and the paint renewed, when required, without *stopping the current.* The cost of painting a double line of *wire when necessary is* about 4*l.* a mile. The telegraph used by

Messrs. Waterlow is the single-needle instrument, requiring only a single line of wire; the double line is put up, in case it may be hereafter found necessary or desirable for any reason to make use of it, the extra cost of stretching a second line at the same time as the first being comparatively small. The cost of a single-needle instrument is 5*l.*; alarums, 4*l.* 4*s.* each. When Mr. Waterlow first proposed connecting the Birchin-lane and London-wall establishments by telegraph, a distance of 1500 feet, he had an estimate prepared of the cost of laying down subterranean wires for the purpose. The estimate was 1200*l.*; by the method adopted the cost was under 30*l.*, exclusive of instruments.—*Proceedings of the Society of Arts.*

HUGHES'S PRINTING TELEGRAPH.

PROFESSOR HUGHES has invented a Printing Telegraph, which seems likely to supersede the instruments hitherto used—at least, on all lines where speed and accuracy are of primary importance. In all electric telegraphs, messages are conveyed by signals, either observed or self-recorded. When observation alone is used, one or two magnetic needles are made, by a passage of electricity through the apparatus, to vibrate to the right or left, at the will of the operator. These signals are arranged into a code, and the receiver spells off the message from the vibrating needles, while an amanuensis commits it, if necessary, to paper. This is the method generally used in Great Britain. In the self-recording instruments the passage of a current of electricity is made to convert a piece of soft iron, or a bundle of iron wires into a temporary magnet; as this magnetism ceases the instant the current of electricity is interrupted, this property is taken advantage of, to attract a piece of iron to the magnet, and set a recording instrument in motion, which, by means of clockwork, records the signals or letters, transmitted on paper at the home and distant stations. These signals are either the actual letters of the alphabet, or may consist of combinations of long and short lines with blank spaces, which stand for the letters of the alphabet. In House's and Brett's printing telegraphs, the Roman letters are used; in Morse's and the telegraphs which follow his principle, the symbols of long and short lines are used. Morse's system is generally used on the continent. In all these instruments, however, most letters require several successive electrical impulses, or waves, to record them. In the telegraph of House or Brett, one letter may require but one wave, another two, and so on; while another may require twenty-eight waves, according as the letters in the message succeed each other in the alphabet. Taking the order in which the letters follow each other in ordinary writing, the average is seven short waves for each letter. In the Morse system the average is three and a-half waves per word; but as long waves are obliged to be used as well as short ones, the advantage in point of speed is found practically to be in favour of House's machine. The recording in print each letter of *a message by a single* wave or electrical impulse is the triumph of *Professor Hughes.* The retardation of the electrical current in sub-

marine and even in insulated wires laid below the surface of the earth, renders this invention of great importance in an economical point of view. If the Atlantic Telegraph is successfully laid down—which we sincerely hope it will be—an electrical impulse will require an interval of nearly two seconds to travel from England to America. These impulses can hardly be sent at shorter intervals after each other than one second. It becomes, therefore, of great importance to adopt an instrument which shall make every impulse record its letter, instead of requiring seven impulses as an average.

We have not space for the description of this new instrument, but quote (from the *Daily News*) the following account of its mode of working.

All the varied operations we have described are performed by the revolution of a small shaft, only about two inches in length, in about the seven-hundredth part of a minute.

As the printing process is seven times faster than the revolution of the hand which makes the contact, it follows that if the keys which represent two consecutive letters of the alphabet be touched at the same instant, the first only would be recorded; but if two keys, five letters distant from one another in the alphabet, be touched at the same instant, they will both be recorded in their proper order. Thus, in spelling the word "independent," the fingers may be placed at the same instant on the keys corresponding to i, n, and d, then on e and p, then on e, n, and d, and lastly on e, n, and t. This method of spelling, as it were in chords, adds vastly to the speed with which a skilful manipulator can make the instrument record its messages. The instrument could work at a much greater speed, but its present rate is quite sufficient to meet the requirements of the most skilful manipulator of the keys.

In using this instrument for transmitting messages between two distant stations—London and Paris, for instance—two similar machines are placed, one at each station, and so arranged that the current of electricity sent by a battery through the wires connecting both stations can be passed through both instruments. Each instrument has a little electro-magnet in the circuit by which a signal is conveyed by a bell, or a simple tick, to warn the receiver that a message is about to be sent. This warning being noticed, the turn of a little brass hand disconnects the warning apparatus from the circuit, and brings the printing apparatus into operation. Both machines are supposed to have the clockwork wound up. By just touching a detent the machines are put in operation. Say that a message is to be sent from London to Paris: the manipulator in London touches the keys of his apparatus, and sees printed before him, by his own machine, the message he wishes to transmit to Paris; but every impulse he sends to Paris enters the machine in Paris, and, if that machine be in unison with the one in London, the Paris instrument prints word for word the same message that the London instrument is recording.

It *is important, therefore,* to bring the rate of the two machines *into unison, and also to* have them so related that both shall simul-

taneously record the same letter. Now, first, as to bringing both into unison. The transmitter of the message invariably commences with the dot. If the two instruments are to be tuned, as it were, and one be faster or slower than the other, the one in London transmits a succession of dots; if these appear in Paris as the same letter, succeeding one another for a few signals, then followed by the next letter of the alphabet for a few signals, then by the next in order, and so on, it follows that the two instruments are not in unison. The Paris attendant simply touches a lever, which raises a brass weight or check on the vibrating spring of his instrument, till its length is the same or its vibrations nearly equal to those of the London instrument. He then signals to London that his instrument is corrected. Now, this first correction need seldom be repeated after the two instruments are once tuned in unison. All minute variations, such as those between two clocks which would gain or lose a few minutes per day, are corrected by the ingenious system of correction which is applied by the printing apparatus of both instruments every time a letter is imprinted. A further correction, however, may require to be used more frequently. The printing wheels at London and Paris may be in different positions, so that when A is printed in London, C may appear at Paris. This error is obviated by the first type sent being the dot, and repeated two or three times if any other type is impressed; the Paris telegraphist simply turns his type wheel as he would turn the minute-hand of his watch, till a dot is recorded by his own instrument; he then transmits to London the letters "O K," which in America are an abbreviation for "All correct," and the message is then forwarded in perfect security that both instruments will record the same succession of letters.

The corrections of the instrument are so easy, and it is worked with such accuracy and rapidity, that it is not astonishing to find that it has been extensively adopted in America. We have seen a paragraph in the *Atlas* and *Argus* of Albany, of the date of June 8, stating that Mr. Hughes's telegraph worked without the least difficulty in the midst of a heavy thunderstorm, without being affected in the slightest degree by the lightning.

OCEAN ELECTRO-TELEGRAPHY.

MONSIEUR BAUDOUIN has forwarded a practical paper to the French Academy of Sciences, "On Means for Preventing the Breakage of Electro-Wires and Submarine Cables," of which the following is the substance:—In a communication addressed to the Academy some months ago, he stated that instead of making a cable—intended to be laid in deep water—solid and heavy, it should, on the contrary, be made of small diameter and light weight; that a cable, the specific gravity of which did not exceed that of the water, would not experience those enormous strains against which it has hitherto been necessary to guard; and that the strain resulting from the immersion of the cable would be found so diminished that, instead of employing checks to regulate the paying out, it would be necessary, on the contrary, to remove everything that would act as a break,

and sometimes to accelerate the cable's descent to coincide with the progress of the vessel.

M. Baudouin asserts that there is no use in making thick cables when the thickness consists in an outward envelope designed to protect the electric wires, and not to benefit them in any way. Hitherto a certain number of copper wires have been covered with insulating materials and then placed in a common insulating envelope, which thus forms the inside of an iron-wire cable. It is evident that all the resistant strength of the cable is in the iron-enveloping wires; but however strong this metallic covering may be, it will stretch considerably under great strain, which, in the case of iron wire, only disturbs the coils without injuring the material; but which, in the case of copper wires placed in the middle of the cable, distends or draws out the particles of metal and snaps them, so that the cable itself does not break, but the electric wires inside the cable. Red copper is extremely ductile, it is true, and can support to a considerable stretching without breaking; but this stretching has its limits, and when they are passed, the metal, if soft, as it may be, is broken, and the electric communication interrupted, as has just occurred in the Mediterranean. To obviate this inconvenience, M. Baudouin was led to reverse the method of making submarine cables; to place in the interior the elements of strength and elasticity, and to use the iron wires thus placed as conductors of electricity.

Thus, in a Transatlantic cable, M. Baudouin proposes, instead of copper wire, which forms the conductor, to substitute a cord of iron wire, six times and a half as thick as ordinary copper wires, in order to get an equivalent conducting power. Six iron wires of three thirty-seconds of an inch each in diameter, wound round a centre, and covered with bitumenized hemp, would suffice. The metallic cord thus formed would be nine thirty-seconds of an inch in diameter: it would unite great flexibility with considerable solidity, and would easily support a weight of 2400 pounds. Such a conductor would be superior to the present ones in resisting the tensile force to which it would be exposed.

It would suffice afterwards to envelope, by the usual process, this metallic cord in several insulated layers, so as to make it of double diameter. By enveloping it afterwards in two layers of hemp, steeped in bitumen, it would gain an impermeability and a solidity more than sufficient for all ordinary wants. Hemp, well steeped in bitumen, does not soon wear ont, inasmuch as it yields considerably before breaking.

In ordinary cables, the greatest resistance is in the surface, which once indented, is easily broken. M. Baudouin's disposition has the advantage of offering more resistance in a smaller compass, and is better arranged, in having several wires to break through instead of one.

Instead of one conductor several might be made use of, by employing several cords of this kind of iron wire, insulating them one by one, and making them strong enough to resist pressure. A cable could thus be formed composed of three, four, or five sets of iron

wires insulated from each other, and all be enclosed in an insulated covering in the manner above described.

But as a cable composed of a certain number of sets of iron wires would be very heavy and bulky, it would be better to augment the number of electric conductors, by joining to the iron wires, which serve already as conductors, a certain number of copper wires, covered lightly, insulated and disposed in spires parallel to and between those of iron wire.

If, as is to be hoped, aluminium, which is such an excellent conductor of electricity, becomes cheaper, and, above all, if alloys of this metal possess a sufficient conducting power, the substitution of aluminium for copper wires will offer great advantages, as much from their lightness as from their tenacity.

Instead of seeking to multiply the number of electric conductors in one cable, M. Baudouin is of opinion that it would be preferable to divide them into several distinct cables, so as to make them lighter, and divide the chances of accidents.—*Building News.*

PATENT ELONGATING TUNNEL TELEGRAPH CABLE.

A NOVEL and ingenious form of Telegraph Cable, adapted to submarine purposes, has been patented by Captain Drayson, R.A., and Captain Binney, R.E. They propose to provide a continuous vulcanized rubber tube (square on the outside and round on the inside), and within this place a copper conducting wire for the conveyance of the current. At intervals along the line the tubing is enlarged, and the wire coiled, the effect being that in the event of the cable stretching the wire is not broken, but simply uncoils to the requisite extent. It is remarked that, in nature, the greatest simplicity of construction and application compatible with efficiency is largely manifested; and this is undoubtedly the desideratum, though generally the last attainment, in art and science. It is well known that perfect and permanent insulation is absolutely necessary to enable a wire to conduct electricity. This insulation is now effected by embedding a copper wire in gutta percha braided over with hemp. The gutta percha is a non-conductor; but it is then enclosed in an iron-wire coating, which is a very good conductor. The copper or message wire is, therefore, separated from that which would at once destroy insulation by (as in the present Atlantic Cable) only one-eighth of an inch of non-conducting substance and some hemp, through which water soon penetrates. This non-conducting substance is softened by moderate heat, and, when warm, yields readily to pressure, and very commonly contains air-bubbles. It will then be readily understood that (by means of the heat and pressure to which the cable is exposed when stowed in the hold of a vessel) the gutta percha is liable to be softened, and the copper wire to be forced through until it nearly or quite touches the hempen layer, which, being only about one-twentieth of an inch in thickness, is of little avail in preventing immediate connexion between the copper and iron. Beside this, the friction inevitably attendant on the paying out, and the heat evolved in consequence, greatly tend to increase the

risk of injury. Although not always perceptible to the operators, it is nevertheless a fact that whenever the electric current is retarded in its transit through the conducting medium, it at once evolves magnetism. The tunnel cable (a full account of which is contained in a pamphlet published by Messrs. Longman) possesses within itself those qualities which will enable it to resist the difficulties by which it will, in deep water, be surrounded.—*Mining Journal.*

CONSTRUCTION OF TELEGRAPH CABLES.

MR. J. MACINTOSH has read to the British Association, a paper, in which he says:

In the ordinary process of expressing the gutta percha through dies in a fluid state, the covered wire as it issues from the die is caused to pass into a long trough containing water, for the purpose of setting it. Each coating goes through the same process; and great difficulty is found in causing the perfect union of the different coatings, which renders the insulation liable to leakage. In order to obviate this difficulty, I coat the wire with gutta percha by means of rollers mounted on parallel axes, and revolving in contact with each other. Each of these rollers is grooved in its periphery, and these grooves meet to form an eye the size of the covering desired. Against these rollers are placed hoppers, in which gutta percha or india rubber is placed, in the state in which it comes from the masticator. The india rubber or gutta percha enters and fills up the grooves of the rollers, and where they come together the gutta percha or india rubber in the grooves is brought together in one piece enclosing the conducting wire; the longitudinal strength and protection are obtained by imbedding fibres of hemp, flax, or cotton in an outer layer of insulating material; this is done with great pressure. This covering is subsequently passed through a bath of sulphuric acid in about twenty seconds, which enables it to resist tropical heat, and affords quite sufficient protection against ill-usage. The shore ends of the cable, or for shallow water, are protected with strong wire.

In place of sulphuric acid, chloride of sulphur might be used, mixed with a solvent, say sulphuret of carbon, to which from two to four per cent. of chloride of sulphur has been added; the covered wire is then passed through this mixture. The speed at which the covered wire passes through the liquid is so regulated as to remain therein about three seconds; this process closing up the pores thoroughly, and rendering it much less likely to be injured by heat or abrasion, and effectually preventing the decomposition of the gutta percha or india rubber.

NEW SUBMARINE TELEGRAPH CABLES.

MESSRS. STEPHENSON and BINKS, of Millwall, have invented an entirely new method of combining the wire covering of Submarine Electric Cables, by which not only increased strength for a given number of wires is obtained in a cable, but its liability to stretch and kink, which are among the chief disadvantages of the present

mode of construction, is entirely obviated. The new cable consists interiorly of four insulated conductors, which are twisted together with rope-yarn, so as to form a very light, though solid rope, of about three-quarters of an inch diameter; over this are braided twelve flat strands of No. 15 gauge iron wire, each strand containing five wires. The operation is performed by the ordinary braiding machine now in use for putting the woollen coverings to the cords of window-blinds, but constructed on an enlarged scale. A cable so constructed would be indisposed to untwist or kink while being payed out or stowed away; and one marked peculiarity in it would be, that to stow it securely on board ship it would be necessary to take it fore and aft on deck, as it could not be coiled away, having no twist in it. This, it is anticipated, would be rather an advantage than otherwise; as there has always been a difficulty in finding ships of sufficient beam to allow electric cables to be stowed on board in coils large enough to avoid undue risk from kinking. Of course, it would be impossible to take any cable, fore and aft in rows, that was not at the same time passive and pliable. This is obtained by covering the ordinary insulating coating of gutta percha with a thick coating of india rubber, which renders it more elastic, and at the same time totally impervious to water at any pressure. The weight of this cable would be 2 tons per mile, so that its specific gravity being low, it would be capable of sustaining many miles of its length in water. Its breaking strain is between 7 and 8 tons, which could be doubled by altering the gauge of the outer wires; and in the case of a wire breaking, it would be impossible for it to strip, and the flexibility would be in no material degree reduced.—*Mining Journal.*

Mr. J. Chatterton, of the Gutta Percha Works, has completed a patent for an invention, causing the wires or strands of wires to pass through a vessel fitted with suitable gauges, and containing an insulating compound of gutta percha or suitable material, rendered more or less fluid by the addition of solvents, and the application of heat immediately before the machine which puts on the ordinary covering of gutta percha. The patentee also electro-plates the copper wires which he employs for electric conductors, in order to render them more suitable to be used for this purpose. He electroplates the copper wire by causing it, after it has first been cleaned by pickling in the usual manner, to pass continuously through a silvering bath, the wire being at the same time in metallic connexion with one pole of a battery, the other pole of which is connected with a plate of silver which is immersed in the bath, as is well understood. The object of electro-plating the wires is to prevent the oxidation of the copper wire. In long lengths of insulated telegraphic wire, he gradually diminishes the size of the conducting wires, so that, as the electric currents become weaker, they will have suitably sized conductors. This part of the invention is applicable to telegraphic wires through which signals are transmitted in one direction only.—*Mechanics' Magazine*, No. 1832.

Mr. Henley, who has completed and shipped off the great Atlan-

lian Cable, has also perfected a Submarine Cable, which is as light and strong as any really good rope is ever likely to be. Its principle of construction is entirely new. The conductor has twice the conducting power of the old Atlantic cable, and is formed after the usual plan of seven copper wires twisted into one strand. The insulation is secured by two thick coats of gutta percha, served round with greased and tarred hemp. The last covering is formed of 18 strands, each strand being composed of three No. 19 fine wires and four tarred strings. The result of this curious mixture of tar and twine is to give to each strand the same strength as if it were all made of wire, with only half the weight. The lowest strain the whole cable breaks at is guaranteed at four tons, though in fact it has never been broken under five. The total weight is 15 cwt. per mile, and only 7 cwt. in water. The advantages of such a submarine rope are too obvious to require pointing out, especially as its cost is calculated at only 100*l.* per mile.

ALLAN'S SUBMARINE TELEGRAPH.

THE new Great Ocean Telegraph Company has been established for the purpose of connecting Great Britain with America by means of Mr. Allan's admirable system of submarine wires. The primary object is, of course, to establish a direct communication between London and New York by a line from the Land's-end to Halifax, the chief naval station of British North America, as well as the inlet to all the telegraphic lines of communication, not only of the Canadas, but of the United States generally. Hereafter the Company intimate that a branch line may be carried by Bermuda to Jamaica, and thence by connecting lines to the other West India Islands, the Central States of America, and the Brazils. By this independent route, starting from the Land's-end, the cost of an average message between London and Halifax will not exceed 30*s.*, as it avoids all the delays and heavy charges consequent on forming working agreements with other Companies. The sea route proposed is also a very good one, though on the average deeper than that across which the Atlantic cable has been laid. This increased depth of water would most undoubtedly be a considerable disadvantage to any Company not working with cables constructed on Mr. Allan's system; but, with these cables, the deeper the water the safer they are,—for their mechanical and physical attributes, combining as they do the *maximum* of conducting power and strength with the *minimum* of weight and specific gravity, render their safe submergence in the greatest depths a very simple mechanical operation.

The chief advantages of Mr. Allan's system of submarine ropes consist in making them of the utmost lightness consistent with their strength—in doing away entirely with the outside covering of spiral wires, and making the core or conductor of the cable its main strength. The weight per mile of the line proposed, from Land's-end to Halifax, is only 10 cwt., while its specific gravity is as low as 1·35,—just sufficient to ensure its sinking very slowly without any strain upon the rope while being payed-out from the ship. The mode

of its construction is one large solid copper wire, or conductor, wound round closely with fine iron wire. This is enclosed in three very thick coats of gutta percha, the whole being bound round with strands of tarred string. We should certainly suggest that the idea of having a solid copper conductor be altered for one of the same diameter, but composed of a number of very fine wires twisted into a single strand. By this plan the chances of a flaw or break occurring to them all at the same place are so reduced as to render such an accident all but impossible. The outside covering of tarred string is also quite unnecessary, and, while giving no strength worth speaking of, adds most materially to the cost per mile. With such slight modifications as these, the cable will be light enough and strong enough to fulfil all the duties which the most sanguine in the new Company can expect of it. Messrs. Glass and Elliot are preparing, upon Mr. Allan's system, a rope which it is said will be lighter in water and stronger than any submarine cable ever yet constructed. —*Abridged from the Times*, December 21, 1858. (See also the details of Mr. Allan's patented plans, in the *Year-Book of Facts*, 1858, p. 164.)

ON SUBMERGING, PAYING-OUT, AND REPAIRING TELEGRAPHIC CABLES.

THERE has been read to the Institution of Civil Engineers, a paper "On Submerging Telegraphic Cables," by Mr. J. A. Longridge and Mr. C. H. Brooke. It was stated at the Meeting of the British Association, at Dublin, in 1857, that "it seemed to be universally admitted that it was mathematically impossible, unless the speed of the vessel from which the cable was payed out could be almost infinitely increased, to lay out a cable, in deep water, say two miles or more, in such a way as not to require a length much greater than that of the actual distance, as from the inclined direction of the yet sinking part of the cable, the successive portions payed out must, when they reach the bottom, arrange themselves in wavy folds, since the actual length is greater than the entire horizontal distance." It was desirable to ascertain how far such a proposition was correct, and if correct, what amount of "slack," or of surplus cable, should be provided to meet the waste in varying depths of water.

The questions discussed in the paper, and of which the mathematical investigations were given in the Appendix, were: 1. The possibility of laying out a cable straight along the bottom, in deep water, free from the action of currents. 2. What degree of tension would be required in the process? 3. What would be the effect, as regarded strain, under the varying circumstances of the depth of water, of the specific gravity of the cable, and of the velocity of the paying-out vessel? 4. What would be the relative velocities of the cable and of the paying-out vessel requisite to reduce the strain or tension to any given amount, and what would be the consequent waste of cable? 5. The effect of currents, and the consequent waste of cable. 6. How far it would be necessary, or safe, to check the velocity of paying-out when passing currents, so as to avoid,

as far as possible, waste of cable? 7. Would it be safe, and if so, under what circumstances, to stop the paying-out, and to attempt to haul in the cable from great depths? 8. The effect of the pitching of the vessel in a heavy sea. 9. The principal desiderata in the paying-out apparatus. 10. The effect of floats, or resisters. 11. The best means for saving the cable in case of fracture. 12. The best mechanical construction of a submarine cable.

After investigating the laws of bodies, such as cables, sinking in a resisting medium, the paper proceeded to show the great waste of cable attendant upon paying-out free from tension at the ship. The form of the curve assumed by a descending cable was then examined, and the amount of tension at the paying-out vessel, requisite to lay the cable without slack along the bottom, estimated under various conditions. The effect of the friction of the water in decreasing this tension, and the result, as regarded the tension, of increasing the velocity of the cable beyond that of the ship, were then pointed out. It was shown that the decrease thus obtained was of small amount, unless the speed of the paying-out vessel was considerable, and that a decrease of tension should rather be sought in a diminution of the specific gravity of the cable. The tension at the ship in 2000 fathoms water was stated to be about 35 cwt. for a cable similar to the Atlantic cable, but with a cable of the specific gravity of 1·5 it would not exceed $7\frac{3}{4}$ cwt.

The effect of currents was then considered, and it was maintained that they did not bring any additional strain upon a cable, and involved only a small loss of length on first entering them. In a hypothetical case of a current extending to a depth of 200 fathoms, and running with a velocity of $1\frac{1}{2}$ foot per second, at right angles to the ship's course, it was calculated that the extra length of cable due to the deflecting action of the current would not exceed 28 fathoms, the velocity of the ship being six feet per second.

The effect of stopping the paying-out was next treated of, and it was shown that it would be to bring a very heavy catenarian strain on the cable, depending upon the depth of water, and the velocity of the paying-out vessel. The amount of this strain for the Atlantic cable in a depth of 2000 fathoms, and at a velocity of the paying-out vessel of six feet per second, was calculated at above seven tons.

The question of hauling in the cable was then adverted to, and the conditions under which it might be safely attempted were pointed out.

After discussing briefly the effect of the pitching of the vessel upon the strain of the cable, the paying-out apparatus was referred to; and the importance of reducing its inertia, and of so constructing the brakes that they should act freely, was maintained. Two plans were then mentioned for saving the end of the cable in case of fracture, and tables were given, showing the velocity and direction taken by the end of the cable under such circumstances.

The authors then proceeded to offer some remarks upon the *mechanical structure of the* cable, and strongly advocated a light cable.

The distinguishing feature of this system of construction was, that the whole of the metallic portion was placed in the centre, and was surrounded by the insulating material; whereas in the Atlantic cable there was an outer sheathing of wire-rope twisted spirally round the insulating medium. It was shown that whilst the absolute weights of the two cables were as 21½ to 10, their relative strengths were as 11 to 25; so that the light cable, weighing scarcely one-half of the heavy one, had nearly two and a-half times its relative strength. The effect of compression and tension on the two constructions was then referred to, and it was maintained that in this respect also the light cable possessed advantages over the other.

In conclusion, the authors, while disclaiming any intention to find fault, expressed their strong conviction that though the Atlantic cable was a step in the right direction, as compared with the heavier cables of former days, it yet fell far short, in mechanical structure and condition, of the light system recommended by Mr. Allan and others. The practicability of safely submerging the present Atlantic cable was not denied, but it was strongly urged that, with a cable of its specific gravity, success would be greatly dependent upon the nature of the paying-out apparatus, and the sedulous attention of those in charge of the brakes.

Next, there has been read to the Institution, a paper "On the Practical Operations connected with Paying-out and Repairing Submarine Telegraph Cables," by Mr. Webb, one of the authors of the preceding communication. The present paper described various operations connected with the repairs of cables; showing, first, the means to be taken to detect the position and nature of the fault, and then those adopted to make the cable good; several operations of this nature, executed by the author in the North Sea, were detailed. Cables which had been broken by anchors, &c., were mended at points varying from two to fifty miles from land—at one time in a tug; at another time in a Dutch fishing-boat; and, lastly, in the *Monarch* steamer, whose fittings for the purpose of general repairs were detailed. The operations of grappling, under-running, buoying, and picking up, were minutely described. In one instance, 120 miles of cable were picked up, repaired on land, and relaid. The paper concluded by pointing out that, by such means, cables could be regularly repaired, and that submarine wires, in shallow seas, became a much less precarious property than they were at first supposed to be.

Four evenings were entirely devoted to the discussion of the two above papers, the deductions in which, it was argued, could not be accepted implicitly. We have not space for the details, save this passage.

The statistics of the submarine cables hitherto essayed showed, that out of forty-three attempted to be laid, six only had failed during the process of laying, four subsequently, and one of the *Hague cables* was at present under repair, leaving thirty-two in *perfect working* order. These facts completely disposed of the assertion that 50 per cent. had either failed in being submerged, or

immediately afterwards. Of the ten total failures, three were strictly light cables, with no outer wires, being the only uncovered cables tried; and the two failures of heavy cables after submersion, arose from their being too light. Several cables had, it was true, been broken by anchors, in consequence of the absence of sufficient iron protecting wires; but these had been immediately repaired, and were now in regular work. Of the six failures in submerging, two occurred with the Mediterranean cables, in the years 1855 and 1856, when 256 miles were lost, of the value of about 70,000*l.*; a third with the Newfoundland cable; a fourth with a light cable from Portpatrick to Donaghadee; a fifth with a heavy cable on the same route; and lastly, the Atlantic cable. Of these, the Newfoundland and the heavy Portpatrick and Donaghadee cables had been recovered.

The communications lately read, and so fully discussed, on the subject of Submarine Telegraphy, have suggested to Mr. A. Varley the inquiry, whether the cables, as at present constructed, did fulfil, in the best manner, the electrical portion of the problem. It was remarked, that there appeared to be some uncertainty, in the minds of those engaged in applying electricity telegraphically, regarding the laws of conduction and induction, and consequently of the nature of the conductor to be employed in long submarine circuits. The conclusions arrived at by the projectors of the Atlantic cable were referred to, as it was believed that some errors had been inadvertently introduced into their calculations; but it was trusted that these criticisms would be received in a friendly spirit, as the only desire was to arrive at the truth.—*Proc. Instit. Civil Engineers.*

THE ATLANTIC TELEGRAPH.

THE following papers have been read to the British Association by Mr. Wildman Whitehouse, the eminent electrician.

The Instruments Employed on the Opening of the Atlantic Line may be classed under the following heads:—

1. The batteries.
2. The induction coils.
3. The manipulator, or transmitting apparatus.
4. The relays and instruments employed to receive the signals, including a new reflecting galvanometer, by Professor Thomson.
5, and last. The apparatus for recording by electro-chemical decomposition.

The battery employed consists of platinized graphite, or retort coke, and zinc of large surface, excited in the usual way, 8 to 12 cells being used as may be required.

The coils are used in pairs, and consist of large hollow iron cores, 5 feet in length, and each wound with the following lengths of copper wire:—

1. With about 11,000 yards of No. 20 gauge silk-covered copper wire, for a secondary circuit, insulated with wax paper between the layers, and hermetically enclosed in gutta percha. And over this a primary circuit of thick wire, No. 14, consisting of 24 parallel circuits of about 100 yards.

3. The key, or transmitting apparatus, consists mainly of a large commutator, or current reverser, kept in constant motion by a train of wheels, and giving regular alternate primary currents to excite the coils; and, by mechanical arrangement and simultaneous action, the shocks from the secondary circuit are sent into the line, and would thus produce a regular succession of marks or dots at the distant station.

Two ivory studs, for hand manipulation and control, are so mechanically arranged and connected, that the tender may, without in any way interfering with the generating part of the commutator, convert these signals into dashes or pauses at will, by the mechanism connected therewith for modifying or entirely diverting or short-circuiting the secondary currents.

4. The relays, &c.

The currents thus generated and controlled are received at the distant end upon a galvanometer, or relay, so constructed and connected with a local printing battery as that every movement shall record itself, by means of a steel stile, upon a slip of electro-chemical paper, kept in constant motion.

The first signals and messages received from Newfoundland were worked off by them, and received by us, precisely in this manner, although, even then, several days having elapsed since the laying of the cable, injury from exposure had begun to interfere with the currents.

Professor Thomson's galvanometer being placed in circuit for the visible examination of the currents so printed, and showing their peculiarities very beautifully, I placed near the observer's hand a finger-key by which he might record the indications of this instrument by a second stile on the identical strip of paper which we were using, several of which slips, containing these records, made for comparison, I now lay before the Section.

Satisfied with the accuracy of the instrument, and with the facility with which we could thus convert its visible signals into indelible records, on the further diminution of the strength of currents from increasing injury, I preferred it to the relay; more especially, because with feeble signals and a varying zero, produced by terrestrial currents, it was capable of being more easily and more accurately used than any form of relay possibly could be.

The eye could easily distinguish the alteration of the zero, and could as easily read off the signals with a constantly varying zero as with the most perfect steady one.

"*Observations made at Keyham on the Varying Velocities of Successive Signals in the Atlantic Cable.*"—The author described a peculiar embarrassment arising from the different rates at which, under some circumstances, successive signals travelled through the cable, some overtaking or encroaching upon those which had preceded them. This was traced to the condition of the cable immediately preceding such signal, and the difficulty was met and effectually removed by the adoption of a system of antecedent compensation.

"*A few Thoughts on the Size of Conductors for Submarine Circuits.*"—Admitting that, for overground telegraphs, the size of the conductor need be limited only by considerations of convenience or expense—and could not, electrically speaking, be too large—the author alluded to the widely different conditions which obtained in submarine conductors, where the loss by induction alone could be shown, under some circumstances, to consume a very large proportion of the whole force employed. He adduced some experiments in which the use of additional insulated conductors as parallel circuits, though of course lessening the resistance to continuous cur-

rents, yet largely augmented the retardation observed upon every signal, and actually diminished their force. He further stated his opinion, that "the induction to which submarine conductors are necessarily subjected, removes this question from the sole operation of those simple laws which regulate the usages of other conductors, and introduces a new element into the calculation, the value and force of which I do not anywhere find fully recognised."

"*Effect of Temperature upon the Insulating Power of Gutta Percha.*"—A series of carefully-noted observations, with diagram, showing that the same length of cable which at 40° Fahr. gave one and a half degree of deflection by its leakage, at 74° Fahr. gave loss to the amount of seventy and a half degrees deflection upon the same instrument. This loss was transient, and ceased altogether on the fall of temperature at night, to return again with its rise the following day.

"*Can a suitable Insulating Material be found possessing a Lower Specific Inductive Capacity than Gutta Percha?*"—Attention was called to this as a means of diminishing the retardation in submarine lines, and a reference made to the use of a compound or adjunct, of great value, recently introduced by the Gutta Percha Company.

"*On some of the Difficulties in Testing Submarine Cables.*"—Among the many difficulties experienced in the use of long submarine lines of telegraph, the process of testing for a fault constitutes not the least. To ascertain the actual amount of loss of current upon any given length of cable as compared with the whole battery force employed, is an easy process; but to determine by any examination made at one end—first, the existence of a fault; secondly, its degree or nature; and, lastly, its position or distance from the operator—may be at times one of the most difficult problems in electro-telegraphic research. The length of the line under examination of course must materially influence the question; for it must be obvious that anything short of absolute perfection in each mile length, or at each joint when multiplied by 2000 or 2500, would give in the aggregate a most striking and almost startling amount of loss. It is this, perhaps, which introduces one of the most embarrassing features; for you are searching for a fault the evidences of which are surrounded and masked by the aggregate effect of myriads of minute microscopic and unavoidable imperfections in the material of which the insulating medium consists. This unavoidable loss necessarily enters as a disturbing element into all the results, and its amount varies with the temperature to which the cable is exposed.

The occurrence of a slight fault at a considerable distance will hardly make an appreciable difference in the amount of loss, while the same amount of injury close at hand may most readily be mistaken for a serious fault at a distance;—to which, indeed, some of the evidences bear the strongest possible resemblance. It admits of demonstration experimentally, that a single mile of cable in which a "variable" fault exists capable of actual graduation by water resistance, *can be made to* assume all the features presented by a serious *fault at any required* distance; the features, that is, as recognised

in the more usual methods of testing by "resistance." I would not be supposed to underrate for a moment the real value of this mode of search and examination; but there are conditions when I believe that the indications derived from it may lead to the formation of most erroneous opinions,—opinions which might wisely be guided and corrected by an appeal to another standard.

I will endeavour to make this difficulty evident by reference to a diagram in its simplest form. We have here a cable of 100 miles in length; test it, and you find its insulation as perfect as may be; now, connect the distant end to earth; test again, and we have "earth" with a resistance equal to 100 miles—taking the mile, if you will, as unity. Change once again, by disconnecting the further end from the earth, and by inserting instead at every mile a very minute fault—say a wetted thread or very fine resisting wire of less than one-hundredth the conducting power of the cable—anything, in fact, so that the aggregate of their resistances or conductivity, together with the cable itself, shall equal the resistance in the previous experiment,—you again have "earth" with a resistance equivalent to 100 miles. It will be found impossible, by the use of the mere resistance tests, to distinguish between these two conditions of experiment. It is under such circumstances that appeal may with advantage be made to another mode of testing, less frequently used, and of course known and introduced only since the discovery of gutta percha: I mean the mode of ascertaining the state of insulation by examining the capabilities of the cable to retain and give back a charge communicating to it—viewing it, in fact, in its special inductive function. It will be found that the many minute points of defect spread over the line diminish the Leyden-jar effect materially, by affording so many points of escape for the current; the defect at the distant end, on the other hand, allows the whole length of 100 miles to be charged up to a certain degree, and on disconnecting the home end from the battery, and instantly passing the discharge from it through any suitable instrument to earth, you receive and may measure the amount thus drawn from one-half the length of the cable, the remainder having discharged itself through the fault at the other end. On the occurrence of the accident to the Atlantic cable last year, when nearly 400 miles were lost, I confirmed my resistance tests by an appeal to this mode of examination before I ventured to state my opinion that the end was either lost or its insulation entirely destroyed at that distance.

The unfortunate casualty to our cable of the present year (1858) was examined by me in this manner, though necessarily very hastily. Sufficient evidence, however, presented itself to satisfy me of the existence of loss upon the cable close at home, at the very time that resistance experiments had determined its site at 600 miles' distance. The matter was put to the test practically by raising the end of the cable in the harbour; and upon little more than half a mile of it there was found to be more loss than I allowed to pass if detected by the use of equal battery power in a hundred miles at the Gutta Percha Works during the process of its manufacture. On that occa-

sion I expressed the opinion that the fault was but partially removed, and that "there was still more to come out." I have seen no reason to alter that opinion.

LAYING THE ATLANTIC TELEGRAPH CABLE.

In the *Year-Book of Facts*, 1858, we recorded the attempt to lay the Atlantic Cable, which terminated by its breaking, when 380 statute miles of its length had been submerged, on August 11, 1857, and this portion of the cable went to the bottom of the ocean. (*See page* 172.)

The second attempt was made in June last, when the ships encountered a succession of south-westerly gales; and in a storm on the 20th and 21st of June, the *Agamemnon* rolled so heavily and dangerously as in her then trim to lead to serious fears that the masts would go overboard, or that she would capsize completely, and founder.

"In these heavy lurches, the coals, which were stowed in the main and lower decks, broke away, and seriously injured several of the crew.

"The electric instruments were all injured. The main coal in the bottom of the hold shifted. The deck boats got adrift. The iron screw guard was wrenched in two, and the waste steam-pipe between the boilers broken, all by the heavy rolling.

"Twice, after every effort had been made to ease the ship, which was much hampered by the upper deck coil of 236 tons forward, it was found necessary to run before the wind, so that it was only on the 25th of June that the rendezvous was made, and the other vessels of the squadron sighted.

"The first splice was made on the 26th, and was broken an hour afterwards on board the *Niagara*, after three miles had been payed out from each vessel. The second splice was also made on the 26th, and broke at 4 A.M. on the morning of Thursday, the 27th, parting apparently at the bottom of the sea, after some miles had been made from each ship.

"The third and last splice parted at 10.30 P.M. on the night of the 29th, about six fathoms below the stern of the *Agamemnon*, after 146 miles had been payed out of that vessel. The *Agamemnon* then returned to Queenstown."

The squadron again left Queenstown on July 17, the amount of cable in the two ships being reduced by nearly 400 miles. The rendezvous was not reached by the several vessels until July 29, when the two principal vessels were made fast by a hawser, and the *Niagara's* end of the cable conveyed on board the *Agamemnon;* the splice was effectually made, and the apparatus was dropped into the sea, when the *Niagara* and *Agamemnon* started for their opposite destinations. We have not space for the very interesting details of the operation, which have been printed in every newspaper in the empire. After a succession of hair-breadth escapes from the gambols of an immense whale, much stormy weather, and collision with two American vessels, the *Agamemnon* and Valorous reached

Valentia on August 5; and soon after, a signal was received from the *Niagara*, that they were preparing to land, having payed out 1030 nautical miles of cable, while the *Agamemnon* had accomplished her portion of the distance with an expenditure of 1020 miles, making the total length of the wire submerged 2050 geographical miles. The end was landed at Kingstown, Valentia, by Mr. Bright and Mr. Canning, the chief and second engineers, and a royal salute announced that the communication between the Old and the New World had been completed—by a curious coincidence, on the same day, August 5, that the Lord Lieutenant of Ireland, in the previous year, assisted to draw it on shore prior to the departure. The end was immediately taken into the electrical room by Mr. Whitehouse, and attached to a galvanometer, and the first message was received through the entire length.

The first telegraphic despatch was from her Majesty the Queen to his Excellency the President of the United States, to which his Excellency replied. The President's message, with address, numbered 143 words as transmitted, and occupied two hours in its passage through the cable, including several "repeats" and corrections. We reprint these interesting records:—

"From her Majesty the Queen of Great Britain to his Excellency the President of the United States.

"The Queen desires to congratulate the President upon the successful completion of this great international work, in which the Queen has taken the greatest interest. The Queen is convinced that the President will join with her in fervently hoping that the electric cable, which now already connects Great Britain with the United States, will prove an additional link between the two nations, whose friendship is founded upon their common interest and reciprocal esteem. The Queen has much pleasure in thus directly communicating with the President, and in renewing to him her best wishes for the prosperity of the United States."

The following is the President's reply to the foregoing:—

"The President of the United States to her Majesty Victoria, Queen of Great Britain.

"Washington City.

"The President cordially reciprocates the congratulations of her Majesty the Queen on the success of the great international enterprise accomplished by the skill, science, and indomitable energy of the two countries. It is a triumph more glorious, because far more useful to mankind, than was ever won by a conqueror on the field of battle. May the Atlantic Telegraph, under the blessing of Heaven, prove to be a bond of perpetual peace and friendship between the kindred nations, and an instrument destined by Divine Providence to diffuse religion, civilization, liberty, and law throughout the world. In this view will not all the nations of Christendom spontaneously unite in the declaration that it shall be for ever neutral, and that its communications shall be held sacred in passing to the place of their destination even in the midst of hostilities.

"James Buchanan."

The landing of the *Niagara's* end of the cable in Trinity Bay, Newfoundland, is thus noted:—

"Thursday, August 5th, 2 A.M.—Ships anchored at the head of Bull's-arm Bay, having payed out since the cable was spliced on the 29th of July, 1016 miles 600 fathoms, in a distance of 882 miles, equal to a loss of about 15 per cent. The Agamemnon signalled she had payed out 1010 miles of cable. At 5 o'clock A.M. the cable

was safely landed. By 6 o'clock the cable was in the telegraph station, and was no sooner connected with the instruments than a current of electricity was received from the *Agamemnon's* end. An impressive scene ensued. On every face the most intense relief and delight were depicted, and all felt it was now their duty to offer up their tribute of prayer and praise to that Supreme Power who had hitherto guided and blessed their efforts. All being assembled in front of the station, Captain Hudson delivered a short address, impressing on his hearers that the glory belonged not unto them, but unto Him who rules the raging of the sea, and holds the waters in the hollow of his hand. Prayers and psalms of thanksgiving were then read, after which all returned to the beach. Three such cheers now burst forth as none but English and American sailors can give; the hills and woods around echoed again and again, the crews of the ships joining in. The *Gorgon* fired a royal salute of twenty-one guns, with American and English ensigns at her mastheads."

Professor Owen, in his eloquent Address to the British Association, thus characterizes this commemoration. After referring to the discoveries in Electro-magnetism, the lecturer continued—Remote as such profound conceptions and subtle trains of thought seem to be from the needs of every-day life, the most astounding of the practical augmentations of man's power has sprung out of them. Nothing might seem less promising of profit than Oersted's painfully pursued experiments, with his little magnets, voltaic pile, and bits of copper wire. Yet out of these has sprung the electric telegraph! Oersted himself saw such an application of his convertibility of electricity into magnetism, and made arrangements for testing that application to the instantaneous communication of signs through distances of a few miles. The resources of inventive genius have made it practicable for all distances; as we have lately seen in the submergence and working of the electro-magnetic cord connecting the Old and the New World. On the 5th of August, 1858, the laying down of upwards of 2000 nautical miles of the telegraphic cord, connecting Newfoundland and Ireland, was successfully completed; and on that day, a message of thirty-one words was transmitted in thirty-five minutes, along the sinuosities of the submerged hills and valleys forming the bed of the great Atlantic. This first message expressed —"Glory to God in the highest: on earth Peace, Goodwill towards Men." Never since the foundations of the world were laid could it be more truly said, "The depths of the sea praise Him." More remains to be done before the far-stretching engine can be got into full working order; but the capital fact—viz., the practicability of bringing America into electrical communication with Europe—has been demonstrated; consequently, a like power of instantaneous interchange of thought between the civilized inhabitants of every part of the globe becomes only a question of time. The powers and benefits thence to ensue for the human race can be but dimly and inadequately foreseen.

The event was celebrated with great festivity at New York, and

by a civic banquet at Dublin; Mr. Charles Bright, the engineer-in-chief, received the honour of knighthood.

We regret to add that, towards the close of August, the condition of the wire became daily more faulty, until the 31st, when a Government message was despatched through the cable for the North American colonies, and on the morning of the 1st of September a second Government message was safely transmitted; but after it had been duly acknowledged, the insulation of the wire became suddenly worse, and it was found impossible to make them understand at Newfoundland; and after 1 o'clock on the morning of the 4th of September, no intelligible signal was received.

The Board of the Company then consulted Mr. Varley, the electrician, who reported on the state of the Atlantic cable as follows:—

I arrived at Valentia on the evening of the 5th September, when I found that no words had for many days been received through the cable from Newfoundland.

On the 6th, 7th, 8th, 9th, and 10th, I tested the cable at intervals in four different ways to ascertain its condition. The following are the results:—

1. There is a fault of great magnitude at a distance of between 245 and 300 statute miles from Valentia, but the locality cannot be more accurately ascertained until a portion of the cable, 20 or 30 miles in length, has been tested against my standard of resistance, and until the log has been consulted to ascertain the amount of slack payed out. I would suggest that the piece of cable at Greenwich be carefully measured and tested against my standard, in order to obtain the most correct estimate of the distance of the fault. Assuming, however, that it is 270 miles, and allowing 22 per cent. for slack, it is possible that the chief defect is in shallow water,—410 fathoms.

2. The copper wire at the faulty place above alluded to does not touch the iron covering of the cable, as is proved by its forming a voltaic element, which gives rise to a continuous positive current from the copper wire varying very little in tension.

3. The insulation of the wire between Valentia and the fault is perfect, or at least contains no defect of sufficient importance to be perceptible, or to materially influence the working were the cable otherwise perfect.

4. The copper wire is continuous, and consequently the cable has not parted. Faint signals, or reversals, are still received from Newfoundland, but the power used will shortly eat away the exposed copper wire in the faulty place by electrolytic decomposition.

The actual resistance of the fault appears to be at least equal to ten miles of the cable, but is most probably greater.

Taking it at its lowest resistance, viz. 10 miles, and assuming that Newfoundland is only using 180 cells of Daniell's battery, the strongest current received thence during my stay was only 1-24th part of the force that it should be were there but this one fault. When it is, however, borne in mind that on the other side they are probably using more power, and also that the defect first alluded to probably offers more resistance than that assumed, viz., 10 miles, it is evident that there is another and more distant fault, the approximate locality of which I could not pretend to estimate at this end without being able to speak to Newfoundland.

From authentic data shown to me at Valentia, I am of opinion that there was a fault on board the *Agamemnon* before the cable was submerged, at a distance of about 560 miles from one end and 640 from the other.

I am also informed that the currents through the cable, even immediately after it was submerged, were so weak that relays were useless, and that not one perfect message was recorded by them, everything that was received being read from the deflections of a galvanometer.

By comparing the above data with those of the new cable now making by Messrs. Glass and Elliot for the Electric and International Telegraph Company, the amount of current which entered the 1000 miles of cable when disconnected at one *end should not* have exceeded 2 or 2·5 parts, instead of 7·5 and 8·5 parts.

The inference by rough calculation, therefore, is that there was a fault offering *a resistance equal* to 1000 or 1200 miles of cable situated at a distance about 580 *miles from one* end of the 1200-mile coil on board the *Agamemnon*.

This, however, cannot be the fault first alluded to, situate at about 270 miles from Valentia, but may have been the one which caused such alarm when the ships were 500 miles from Ireland, and when the signals ceased altogether and never certainly recovered.

It is not at all improbable that the powerful currents from the large induction coils have impaired the insulation, and that had more moderate power been used, the cable would still have been capable of transmitting messages.

To satisfy myself on this point, I attached to the cable a piece of gutta percha-covered wire, having first made a slight incision in the gutta percha to let the water reach the wire; the wire was then bent so as to close up the defect. The defective wire was then placed in a jug of sea-water, and the latter connected with the "earth." After a few signals had been sent from the induction coils into the cable, and, consequently, into the test wire, the electricity burnt through the incision, rapidly burning a hole nearly one-tenth of an inch in diameter.

When the full force of the coils was brought to bear on the test wire by removing them from the cable and allowing the electricity only one channel—viz., that of the test wire—the discharges, as might be expected, burnt a hole in the gutta percha under the water, half an inch in length, and the burnt gutta percha came floating up to the surface.

The foregoing experiments prove that when there are imperfections in the insulating covering there is very great danger arising from using such intense currents.

Mr. Henley, the well-known electrical engineer, next thus reported to the Company the result of his investigations into the cause and seat of the fault in the cable:

That the cable is not severed we have abundant proof; but that any one can, by the most delicate tests, discover whether the conducting wire is so or not in a cable of this length, I utterly deny. Should such be the case, it does not follow that the line must be rendered useless.

If by any means the conducting wire separates, and the gutta percha remains sound, all communication ceases, from the absence of moisture to complete the circuit. By our testing, one fact is unquestionably established, and that is, the fault is not beyond 300 miles. I speak of the great fault. Others may exist between that and Newfoundland; but if it be a fact (as I have heard) that on testing at the latter place very little earth is shown, the probability is that the other part of the cable is good.

In my opinion, the fault or faults existed in the cable before it was submerged, and that they would have been detected and made good, had the precaution been observed of having the whole cable tested in water during its manufacture. Its not showing so bad when first laid is easy to be accounted for, as it takes some time for the water to soak through the coating of pitch and tar.

Had your cable been injured after submersion by resting on the sharp edge of a rock, the inner wire and the outer metallic covering must have come in contact, and that this is not the case we have absolute proof, both from the fact of a battery current being generated by the iron sheathing and the exposed copper, and from signals being received from Newfoundland; for did the iron touch the copper conductor in the smallest point, not the slightest signal could be observed. Signals were, from the first, much weaker than they ought to have been from a tolerably insulated line of length, and were scarcely sufficient to work a very delicate relay (which can be used with a current so feeble that it could only just be detected on the tongue). The currents now received are not more than a tenth of that power.

Mr. Henley then says that "earth currents,"* or natural currents of electricity, must always disturb submarine and subterranean lines (like the atmospheric currents, as they are termed in overground wires).

* Mr. W. H. Barlow claims to have discovered these terrestrial electric currents while engaged in erecting the telegraph on the Midland Railway in 1846-7. The *following facts were then established*:—That the currents possessed a diurnal *variation, their direction being* generally from S.W. to N.E. at one period of the

On a line of such enormous length as the Atlantic cable, electric disturbance is sure to take place on some part of it at all times; and if a current is set in motion in any part, the effect is communicated throughout the whole.

In another part of his Report, Mr. Henley expresses an opinion that "four words per minute will be the maximum rate of transmission through any Atlantic cable with the present dot and dash system. If other plans can be worked, by which a letter would be indicated by one or two signals, the rate would be increased in proportion," which would be most desirable.

Meanwhile, the Telegraph is in the charge of Mr. Henley, who has constructed two gigantic electrical machines, to try and send signals, as it were, by main force. They are the largest yet made: the two permanent magnets from which the electric induction is obtained are each composed of thirty horse-shoe magnets, two feet and a-half long, and from four to five inches broad; the induction coils attached to these, each contain six miles of wire; and a shock from it, if passed through the human body, would be sufficient to destroy life.

No attempts can be made, with any prospect of success, to lift the cable until the return of calm weather at the end of April or May, and, even under the best circumstances, the expectations with regard to the operation are not favourable. Meanwhile, it has been definitively ascertained that the existing damage was not at the shore end. The laying of the new end was completed to a distance twelve miles out from Valentia, and the portion taken up was found to be in a perfect condition for all electrical purposes. Experiments since undertaken by a person previously unconnected with the enterprise strongly support the original inference, that the main fault is about 270 miles from the Irish coast, at a depth probably of 900 fathoms. There is also a fault on the other side, which is thought to be about 300 miles from Newfoundland.

day, and from N.E. to S.W. the rest of the twenty-four hours; that these electrical storms were frequent, and were always accompanied by similar disturbances of the magnetic needle. During the submergence of the Atlantic Telegraph wire, these facts have been confirmed and further elucidated. When the first unsuccessful attempt was made, the wire parted at about 350 miles from the Irish coast. This submerged portion remained attached to the shore end for a considerable period; the phenomena of earth currents were then also observed. Their effect was to deflect rapidly the needle of the galvanometer, just as if signals were being sent. The periods of greatest vibration were at ten in the morning and at ten at night, and they were always least felt one hour later. When the Atlantic wire was first laid, and the signals passed from point to point, the earth currents were scarcely perceptible; but as the insulation became gradually more imperfect, the earth currents overpowered the electric currents, rendering the signs almost unintelligible. As long, therefore, as there is any defect in the line, these magnetic storms will always interfere with the action of the electric signals. Such are the facts connected with this singular phenomenon.

Chemical Science.

ELEMENTARY BODIES.

Professor Owen, in his Address to the British Association, in characterizing the progress of Chemical Science, observed that the present tendency of the higher generalizations of chemistry seems to be towards a reduction of the number of those bodies which are called "elementary;" it begins to be almost more than suspected that certain groups of so-called chemical elements are but modified forms of one another. Already natural processes can be more economically replaced by artificial ones in the formation of a few organic compounds, the "valerianic acid," for example. It is impossible to foresee to what extent chemistry may not ultimately, in the production of things needful, supersede the present vital agencies of nature "by laying under contribution the accumulated forces of past ages, which would thus enable us to obtain in a small manufactory, and in a few days, effects which can be realized from present natural agencies only when they are exerted upon vast areas of land, and through considerable periods of time."

Sir John Herschel, in taking the chair in the Chemical Section of the Association, made the following remarks upon this important subject :—

"Perhaps I may be tolerated if I put in a word of reclamation against the system of notation into which chemists, who for the most part are not algebraists, have fallen, in expressing their atomic formulæ. These formulæ have been gradually taking on a character more and more repulsive to the algebraical eye. There is a principle which I think ought to be borne in mind in framing the conventional notations as well as nomenclatures of every science, at every new step in its progress—viz., that as sciences do not stand alone, but exist in mutual relations to each other—as it is for their common interest that there should exist among them a system of free communication on their frontier points—the language they use and the signs they employ should be framed in such a way as at least not to contradict each other. As the atomic formulæ used by the chemist are not merely symbolic of the mode in which atoms are grouped, but are intended also to express numerical relations, indicative of the aggregate weights of the several atoms in each group and the several groups in each compound, it is distressing to the algebraist to find that he cannot interpret a chemical formula (I mean in its numerical application) according to the received rules of arithmetical computation. In a paper which I published a long time ago, on the Hyposulphites, I was particularly careful to use a mode of notation which, while perfectly clear in its chemical sense, and fully expressing the relations of the groupings I allude to, accommodated itself at the same time perfectly well to numerical computation, *no symbol being in* any case juxtaposed, or in any way inter-*combined with one* another, so as to violate the strict algebraical

meaning of the formula. This system seemed for a while likely to be generally adopted; but it has been more and more departed from, and I think with a manifest corresponding departure from intelligibility.

"The time is perhaps not so very far distant when, from a knowledge of the family to which a chemical element belongs, and its order in that family, we may be able to predict with confidence the system of groups into which it is capable of entering, and the part it will play in the combination. A great step in this direction seems to me to have been lately made by Professor Cooke, of the Havard University, of the United States, (in a memoir which forms part of the 5th volume of the Memoirs of the American Academy of Arts and Sciences,) to extend and carry out the classification of chemical elements into families of the kind I allude to, in a system of grouping, in which the first idea, or rather the first germ of the idea, may be traced to a remark made by M. Dumas, in one of his Reports to this Association, and which is founded on the principle of arranging them in a series, in each of which the atomic weight of the elements it comprises is found among the terms of an arithmetical progression, the common difference of which in the several series is 3, 4, 5, 6, 8, and 9 times the atomic weight of hydrogen respectively. So arranged, they form six groups, which are fairly entitled to be considered natural families, each group having common properties in the highest degree characteristic; and what is more remarkable, the initial member in each group possessing in every case the characteristic property of the group in its most eminent degree, while the others exhibit that property in a less and less degree, according to their rank in the progression, or according to the increased numerical value of the atomic equivalent.

"Generally speaking, I am a little slow to give full credence to numerical generalizations of this sort, because we are apt to find their authors either taking some liberties with the numbers themselves, or demanding a wider margin of error in the application of their principles, than the precision of the experimental data renders it possible to accord, so that the result is more or less wanting in that close appliance to nature which makes all the difference between a loose analogy and a physical law; but in this instance it certainly does appear that the groups so arising not only do correspond remarkably well in their theoretical numbers with those which the best authorities assign to their elements, but that it really would be difficult to distinguish the elements themselves into more distinctly characteristic classes by a consideration of their qualities alone, without reference to their atomic numbers. When we find, for instance, that the principle affords us such family groups as oxygen, fluorine, chlorine, bromine, and iodine, self-arranged in that very order; or again, nitrogen, phosphorus, arsenic, antimony, or bismuth; when we find that it packs together in one group all the more active and soluble electro-positive elements, hydrogen, lithium, sodium, and potassium, and in another the more inert and less soluble ones, calcium, strontium, barium, and lead—and that without outraging any other sys-

tem of relations, it certainly does seem that we have here something very like a valid generalization; and I shall be very glad to learn in the course of any discussions which may arise on such matters as may be brought before us in the regular conduct of our business from those more competent to judge than myself, whether I have been forming an overweening estimate of the value and importance of such generalizations.

"I will only add on this point, in reference to what fell from our excellent President in his address to the assembled Association last night, that this kind of speculation followed out would seem to me likely to terminate in a point very far from that which would regard all the members of each of these family groups as allotropes of one fundamental one, inasmuch as the common difference of the several progressions which their atomic weights go to make up, are neither equal to nor in all cases commensurate with the first terms of these progressions. For instance, in the chlorine group, the first term being eight, the common difference is nine. Something very different from allotropism is surely suggested by such a relation. It would rather seem to point to a dilution of energy of one primary element by the super-addition of dose after dose of some other modifying element, and this the more strikingly since we find oxygen standing at the head of very distinct groups having very striking correspondences in some respects, and very striking differences in others. But all these speculations take for granted a principle with which, I must confess, I think chemists have allowed themselves to be far too easily satisfied—viz., that all the atomic numbers are multiples of that of hydrogen. Not until these numbers are determined with a precision approaching that of the elements of the planetary orbits,—a precision which can leave no possible question of a tenth or a hundredth of a per cent., and in the presence of which such errors as are at present regarded as tolerable in the atomic numbers of even the best determined elements shall be considered utterly inadmissible,—I think, can this question be settled; and when such gigantic consequences—so entire a system of nature is to be based on a principle, nothing short of such evidence ought, I think, to be held conclusive, however seductive the theory may appear. I do not think such precision unattainable, and I think I perceive a way in which it might be attained, but one that would involve an expenditure of time, labour, and money, such as no private individual could bestow on it. If the phenomena of chemistry are ever destined to be reduced under the dominion of mathematical analysis, it will, no doubt, be by a very circuitous and intricate route, and in which at present we see no glimpse of light.

* * * * * * *

"There is another class of phenomena which, though usually considered as belonging peculiarly to the domain of general physics, and so out of our department, seems to me to want some attention in a chemical point of view. It is that of capillary attraction. The co-efficient of *capillarity* differs very remarkably in different liquids, *and no doubt also* in their contacts with different solids, a fact which

can hardly be separated from the idea of some community of nature between the capillary force and those of elective attraction. I hardly dare to hint at the existence of some slight misgiving I have always felt as to the validity of the received statical theory of capillary action, which carries with it the authority of such names as those of Laplace and Poisson. Any discussion of this point would be matter for another Section of this Association; and if I here touch upon it, it is only to observe, that my impression of the requisiteness of a force *so far allied to chemical affinity as to be capable of saturation*, rests on other grounds besides that of the mere diversity of action above alluded to. But I must remember that you are not met here to listen to generalities, of whatever nature, but that we have plenty of real and special business before us. In the several papers which will be brought before this Section—in the elucidation their authors will personally afford, and in the discussions which will take place on them—I look forward to rich accessions to our knowledge, and to pregnant and fertile suggestions which will afford us matter of fruitful meditation hereafter; and I am very sure, that in the course of such discussion as may involve differences of opinion, that spirit of mutual and amicable concession which has always characterized the meetings of this Section will continue to prevail."

CONDUCTIBILITY OF METALS AND ALLOYS.

A COMMUNICATION has been read to the Royal Society, "On the Relative Power of Metals and their Alloys to Conduct Heat," by Mr. J. Crace Calvert and Mr. Richard Johnson.

After describing the apparatus and process, the authors give the chemical means by which they purified the metals used in the experiments. Taking silver, which is the best conductor, as 1000, they obtained the relative conducting powers of the following metals:—

Silver	1000	Forged iron	436
Gold, $\frac{1000}{1000}$	981	Tin	422
Gold, $\frac{991}{1000}$	840	Steel	397
Copper, rolled	845	Platinum	379
Copper, cast	811	Sodium	365
Mercury	677	Cast iron	359
Aluminium	665	Lead	287
Zinc, forged	641	Antimony, cast horizontally	215
Zinc, cast vertically	628	Antimony, cast vertically	192
Zinc, cast horizontally	608	Bismuth	61
Cadmium	578		

The precision obtained by this process is such, that the authors were able to determine the different conducting powers of the same metal, when rolled or cast, as shown above. They were also able to appreciate the influence of crystallization on conductibility; for they found that the conducting power of a metal was different when it was cast horizontally or vertically, from the different directions which the axes of crystallization took under these circumstances.

The importance of having the metals as pure as the resources *of chemistry allow*, is shown by the action which one per cent. *of impurity* exerts on the conductibility of a metal, in some cases

reducing it one-fifth or one-fourth. Copper alloyed with one per cent. of various metals gave different conducting powers, in the same manner as Mr. Thomson has shown that the conduction of electricity by the same metal is affected by a similar amount of impurities.

Alloying a metal with a non-metallic substance also exerts an influence, as is shown in the case of the combination of iron with carbon, thus :—

Forged iron	436
Steel	397
Cast iron	359

Similar results were obtained by combining small proportions of arsenic with copper.

The authors, with a view of ascertaining whether alloys are simple mixtures of metals, or definite compounds, made a large number of alloys of various metals, using equivalent proportions, and determined their conducting powers. The general result obtained is, that alloys may be classed under the three following heads :—

1st. Alloys which conduct heat in ratio with the relative equivalents of the metals composing them.

2nd. Alloys in which there is an excess of equivalents of the worse conducting metal over the number of equivalents of the better conductor, such as alloys composed of 1Cu and 2Sn; 1Cu and 3Sn; 1Cu and 4Sn, &c., and which present the curious and unexpected result that they conduct heat as if they did not contain a particle of the better conductor; the conducting power of such alloys being the same as if the square bar which was used in the experiments were entirely composed of the worse conducting metal.

3rd. Alloys composed of the same metals as the last class, but in $a^2+c^2>3b^2$; and the memoir contains a figure showing the form of the surface for the case in question. The equation of the surface is obtained by the elimination of X, Y, Z between the above-mentioned equations and the equation $\frac{X^2}{a^2}+\frac{Y^2}{b^2}+\frac{Z^2}{c^2}=1$, as already remarked. This is reduced to the determination of the discriminant of a quartic function, and the equation of the surface is thus obtained under the form $I^3-27J^2=0$, where I and J are given functions of the coordinates.

COMBUSTIBILITY OF METALS.

A paper has been read to the British Association, "On the Combustibility and other Properties of the Rarer Metals," by Dr. A. Matthiessen. It embraced a description of the very beautiful metals obtained from the alkalis and alkaline earths, and was illustrated by the exhibition of a variety of these metals, as attractive as unusual. *The specimens of sodium*, lithium, potassium, calcium, strontium,

&c., were regarded with great interest, and their combustion in an intensely brilliant white light elicited frequent expressions of admiration. Their extreme lightness was dwelt on, lithium being lighter than any liquid, and possessing little more than half the specific gravity of water. From magnesium the combustion resulted in an ash hollow throughout.—*Athenæum*, No. 1616.

SODIUM AND POTASSIUM.

A CORRESPONDENT of the *Mechanics' Magazine* states that Sodium may be fired in the same way as Potassium, by the action of (cold) water. The metal potassium, when thrown into water, receives the oxygen on account of its affinity for the same, and liberates the hydrogen (the other element of water); the heat evolved by its union with the former substance being sufficient to set the escaping hydrogen on fire, which burns with a bluish light. The metal sodium, when thrown into (cold) water, acts in the same manner as the afore-mentioned substance, but the heat evolved during the absorption is not sufficient to fire the hydrogen, which, therefore, *escapes* unnoticed. This is a well-known fact.

But if we wrap up the sodium in some cotton-wool, the heat by this means is augmented as the oxygen is condensed, and the sodium, being fired, rushes out of the cotton wool, burning upon the surface of the water with a yellow flame. Hence we see that sodium may be fired by its union with water in the same way as potassium. Most works on chemistry deny the possibility of firing sodium by the action of water—the writer believes it.

THE PRODUCTION OF ALUMINIUM.

M. PETITJEAN, a French chemist, resident in London (the inventor of an admirable method of silvering mirrors cheaply, which was brought to the notice of the Royal Institution some time since by Professor Faraday), has effected an improvement in the production of Aluminium, which promises to still further reduce the cost of that valuable metal beyond all that has hitherto been anticipated. His invention consists in transforming so much of the aluminium as is present in the substances with which it is found naturally combined into one or more sulphurets; and then removing the sulphur therefrom by the aid of carbon, or a hydrocarbon, or of a suitable metal or metals, mixed therewith, and exposed in a crucible to a high temperature, after which the aluminium in a metallic state will be deposited in the crucible. The process is equally applicable to the production of magnesium.

Sir F. C. Knowles, Bart., has also patented a new process for the manufacture of Aluminium. His invention consists of a method of preparing the cyanides of potassium and of sodium, and in the use of those cyanides in the making of the aluminium. To form the cyanides, the patentee combines anhydrous carbonate of potash or anhydrous carbonate of soda, as the case may be, with fine charcoal, in such a proportion as to convert the carbonic acid into

carbonic oxide by the action of heat, and to decompose the alkali used. He places this mixture in a chamber with lumps of charcoal, such chamber being of fire-clay, fire-brick, or iron; and then, having heated the same sufficiently, he passes through it a current of the waste gases of blast furnaces used in smelting iron ores, or of the same or similar gases obtained intentionally from a cupola by a blast of air. The nitrogen contained in these gases combines with the charcoal to form cyanogen, and this, uniting with the metallic base of the decomposed alkali, forms a vapour of the cyanide required, which can be collected by sublimation in appropriate chambers and cooled. To make the metal aluminium, he takes one or other of the above cyanides and the chloride of aluminium, and by passing the vapour of the chloride of aluminium through or otherwise combining the same in the form of melted chloride, or its vapour, with the melted cyanides or their vapour, he obtains, by double decomposition, chloride of sodium, or chloride of potassium and the metal aluminium, which can be readily collected and fused. Pure alumina may be added to the materials to increase the yield of metal and to economize the cyanide, and this he recommends to be done in most cases.—*Mechanics' Magazine*, No. 1806.

PRACTICAL APPLICATION OF ALUMINIUM.

MR. R. REYNOLDS presented to the Chemical Section of the British Association, at their late meeting at Leeds, a spoon and fork manufactured by Messrs. Coulson and Co., of Sheffield. The spoon closely resembled silver in colour, having, however, perhaps a faint tinge of blue. It could be produced at about half the cost of silver. The weight was only two and a half times that of water, and one-third that of silver. The sensation of handling so light a metal was a very singular one. On the Continent, the manufacture of aluminium is pretty general, brooches, studs, &c., being made of it in consequence of its offering, with an alloy of copper, a very close resemblance to gold, in all but the property of weight. Mr. Coulson had stated that with from 5 to 10 per cent. of aluminium he could obtain any shade of gold.

FROSTED ALUMINIUM.

DR. MACADAM has read to the British Association a "Note on the Production of a Frosted Surface on Articles made of Aluminium." Some aluminium had a short time previously been obtained for the purpose of making medals. When the medals were struck, a peculiar grey appearance was noticed on their surface, which it was supposed arose from the uncleanness of the die. Close examination, however, showed that this was not the case. Some of these medals were subjected to the action of hydrochloric acid and nitric acid separately, without producing much effect on their surfaces. When some of them were put into a solution of caustic potash they were acted on very violently, hydrogen being evolved, and the surface of the metal *becoming beautifully* frosted. This phenomenon of an *alkali comporting itself* to a metal as acids do, is worthy the atten-

tion of chemists. After aluminium has been frosted in this manner, it does not become tarnished on exposure to the action of the air.

BLASTING WITH GUN-COTTON.

SOME interesting experiments relative to the Blasting of the bastions at Vienna have been made. The "bohr-löcher" (holes, which are bored six feet deep) received a very trifling charge of powder or gun-cotton, as the bastions are but half-a-dozen paces distant from the houses. It is generally said that gun-cotton produces three times the effect of gunpowder; but military engineers aver that the effect which the explosion of a certain quantity of gun-cotton will produce can never be exactly foretold. If the cotton is very strongly compressed when the electric spark is applied to it, the effect which it produces is very great; but if it is at all loose, it is much less efficacious than gunpowder. If a few pounds of powder explode in a room, the devastation must necessarily be great; but if the same weight of gun-cotton is strewn loosely on the floor and then ignited, a sudden "puff" takes place, but the articles in the room are uninjured. The Austrian Government has expended a great deal of time and much money in making experiments; but it is beginning to discover that powder is preferable to cotton.

OXY-HYDROGEN LIGHT.

AN improvement in preparing materials employed in obtaining Light when Oxygen and Hydrogen gases are used, has been patented by Mr. James Copcutt, of Kensington. The gypsum or other material used is first raised to, and retained for a time at, a red heat, in a crucible, in which a small quantity of sulphur is introduced: 5 lbs. of sulphur are mixed with the ton of stuff. The mixture is raised to a red heat in a covered crucible or oven, and is kept at this heat for about twenty-four hours: it is afterwards allowed to cool, and cut into pieces of suitable form for use. The light is obtained by throwing an ignited jet of oxygen and hydrogen gases on to the gypsum.—*Builder*, No. 829.

ARSENIC IN PAPER-HANGINGS.

IN the *Year-Book of Facts*, 1858, we quoted a portion of Dr. Swaine Taylor's Evidence before Parliament, on the poisonous employment of Arsenic in Paper-hangings, strongly denouncing the use of green papers, from their being coloured with arsenite of copper. The subject has been accordingly brought under the notice of the Commissioners of Inland Revenue, who have issued their Report of a thorough investigation into the matter; and, from the experiments made by Mr. Phillips, it is said to have been demonstrated that the alarming statements which have been made on this subject are without foundation. Mr. Phillips says that he and his family occupied a sitting-room three years, the walls of which were *covered* with paper laden with arsenite of copper, and experienced *not the slightest* ill effect from it.

Dr. Taylor has, however, since adduced the following additional

evidence in support of his conclusions. A friend, whose library walls were covered with an arsenical paper, had suffered from chronic inflammation of the eyes. On causing the paper to be removed, and to be replaced by another containing no arsenic, the inflammation disappeared; but within the last few weeks it returned. He informed me that he had been dusting some books in a book-case in this room, and he supposed that the dust had caused a return of the inflammation. Some of the dust was carefully removed by a feather, and submitted to a chemical analysis. The dust weighed one grain and a half; it had an olive-green colour; and under the microscope it presented the appearance of fibres, with numerous particles of various colours, chiefly of a greyish black. Treated by Reinsch's process, a portion of this dust yielded a deposit of arsenic, affording clear evidence that some of the arsenical pigment formerly on the walls had found its way through the glass doors of the book-case, and had been deposited in the form of a fine dust on the tops of the books. Dr. Taylor then procured from the walls covered with an unglazed arsenical paper, about four hundred and fifty grains of dust: it was nearly black, and under the microscope it appeared to consist of fibres and sooty particles, very light and flocculent. One hundred and fifty grains of the dust were examined by Reinsch's process, and enough metallic arsenic was obtained from this quantity to coat about ten square inches of copper-foil, in addition to a piece of copper-gauze. From the deposit on the latter, by the application of heat, octahedral crystals of arsenic were readily obtained. The cases had not been dusted for a period of nine months. From these facts, Dr. Taylor concludes that there is, at any rate, great risk in having rooms papered with unglazed hangings coloured with the poisonous arsenite of copper.

SULPHATE OF BARYTES.

M. Kuhlmann, who was the first to apply this substance to house-painting, has read a paper on the subject to the French Academy of Sciences. Sulphate of barytes is white, and is preferable both to white lead and to oxide of zinc, not only on account of its durability, but also because it produces no injurious effects upon the health of the workmen. To obtain it, M. Kuhlmann first deprives the natural carbonate of barytes, or witherite, which exists in large deposits in the north of England, of its carbonic acid, by putting it in contact with the vapours of hydrochloric acid issuing from the furnaces where sea-salt is decomposed for the purpose of obtaining soda; after which he transforms it into a sulphate by the addition of sulphuric acid. The sulphate is afterwards well washed, in order to deprive it of every trace of the acid. The excess of water is then expelled either by pressure or swift rotation, and the paste which remains is put into barrels for sale. Sulphate of barytes might be reduced to the form of dry cakes like white lead, but it is preferable to keep it in the state of a paste, because, when once dry, it cannot be again reduced *so easily* to a fine powder, such as it was when *first precipitated. It is* used with great advantage in the manu-

facture of paper-hangings, and has been successfully applied to oil-painting, a coating of this paint being much more durable than any other known. In examining the rubbish remaining after the demolition of one of his furnaces for the transformation of chloride of barium, M. Kuhlmann observed a green and blue substance, strongly resembling ultramarine; and, in presenting a sample of it to the Academy, expressed his belief that it would not be impossible to obtain artificial ultramarine from barytes.

PAVIINE.

PROF. STOKES has read to the Chemical Society, a paper "On the Existence of a second Crystallizable Fluorescent Substance, Paviine, in the Bark of the Horse Chestnut Tree." This substance is closely allied to æsculine; but differs in the colour of its fluorescent light, which is bluish-green, instead of sky-blue; in its greater solubility in ether, so that it can be obtained crystallized from its ethereal solution; and in its superior tendency to combine with oxide of lead, so that the two substances can be partially separated from one another by fractional precipitation with acetate of lead.

SOLUBLE SALTS.

DR. GLADSTONE has read to the Chemical Society, a paper "On the Chemical Action of Water on Soluble Salts." The author showed that when the concentrated solution of a coloured salt was diluted with varying quantities of water, the absolute quantity and character of the colour were not usually interfered with, but that remarkable exceptions occurred, particularly in the bromides of the ferrocupric class of elements.

NEW UREAS.

DR. HOFMANN has described to the Chemical Society, some New Ureas that he has recently produced, in which half the nitrogen was replaced by phosphorus, the whole of the hydrogen by ethylic radicals, and the carbonic oxide by carbonic sulphide. These new ureas are interesting also from their property of combining directly with chloride and bromide of ethyle.

PROPIONIC ACID.

Mr. J. A. WANKLYN has read to the Chemical Society, a paper "On a New Method of Preparing Propionic Acid." The author first obtained a new compound, sodium-ethyl, by the reaction of sodium upon zinc-ethyl; and this sodium-ethyl, when treated with carbonic acid, becomes converted into propionate of soda. This formation of propionic acid is a synthetic experiment, correlative to Kolbe's well-known analytic experiments on the decomposition of the fatty acids.

BROMINE AND ACETIC ACID.

MESSRS. PERKIN and DUPPA have read to the Chemical Society, a paper "On the Action of Bromine on Acetic Acid." The authors

prepare bromacetic and bi-bromacetic acids by effecting the reaction of bromine on crystallizable acetic acid in sealed tubes heated to 150° C. Several salts and ethers of both acids are thus prepared. Bromacetic acid is found to react in a most interesting manner with ammonia, yielding as a result glycerine or sugar of gelatine. This reaction consists in a substitution of amidogen for bromine.

URARI POISON.

MR. H. HANCOCK has read to the Chemical Society, a paper "On the Urari Poison obtained from Arrows." Some poisoned arrows, brought over from Guiana by Sir R. Schomburgk, were scraped, and the scrapings digested in chloroform. By evaporating off the chloroform, a crystalline, highly poisonous deposit was obtained.

IODIDE OF ALUMINIUM.

WEBER describes, in Poggendorff's *Annalen*, the preparation of Iodide of Aluminium. One part of aluminium in filings is placed in a sealed tube, and ten or eleven parts of dry iodine added. The tube is then sealed at the other end and gently heated. Combination takes place with strong evolution of light and heat: the granules of aluminium burn with a splendid violet light. On cooling, the iodide appears as a solid mass coloured brown by excess of iodine; by using a slight excess of metal, and resubliming the iodide once or twice, it is obtained pure. It forms then brilliant white crystalline laminæ, which melt to a very mobile liquid; on further application of heat this boils readily, and sublimes in delicate snow-white laminæ in the colder part of the tube. Exposed to the air, it fumes strongly, and readily deliquesces. Heated in the air it decomposes with the liberation of iodine. The formula of the iodide is $Al^2 I^3$, quite analogous to the chloride. Iodide of aluminium forms with water a compound which is probably a hydrate. It also forms with iodide of potassium a double compound. This is a waxy, transparent, crystalline mass, which readily melts, but sublimes with difficulty. It has the formula $Al^2 I^3 KI$.

IODIZED FOOD.

AT the French Academy of Medicine of Paris, Dr. Boinet has read a paper in which he proposed the introduction of Iodine into the daily food of persons labouring under any of the diseases in which that element is chiefly prescribed, or else having a constitutional tendency to contract them. Considering that wens, cretinism, scrofula, &c., are very rare in those regions where iodine is abundantly diffused through the air, and that the energy of the vital functions is in the direct ratio of the quantity of iodine existing in the animal economy, Dr. Boinet proposes to iodize bread, cakes, syrups, &c., simply by the introduction of such plants as naturally contain iodine—viz., all kinds of sea-weeds and cruciferous plants; or else by using the water of iodized springs, or salts containing the same principle. Under these forms the quantity of iodine administered is so small as to communicate no peculiar taste to the edible

substance. After ten years' experience, during which Dr. Boinet has treated children especially selected by a physician of a *bureau de bienfaisance* for their scrofulous habit, he has come to the conclusion that the diet he proposes, if persevered in for some months, will not only cure scrofula, but ulcerous habits, diseases of the skin, ophthalmia, caries of the bones, &c. The Academy of Medicine has referred Dr. Boinet's paper to a commission composed of Drs. Chatin and Trousseau.

CALCIUM.

M. DUMAS has read to the French Academy of Sciences, a Report "On a Chemical Process for Extracting Calcium," lately submitted to the Academy by MM. Liès-Bodart and Jobin. Calcium is one of the alkaline metals, and is contained in lime: it was first obtained through the action of the pile by MM. Bunsen and Mathiesen, but in very small quantities, and with great trouble; by chemical decomposition it had never been obtained. M. Dumas himself, about thirty years ago, vainly attempted to extract calcium from its iodide by means of potassium; but the operation being performed in the open air, the alkaline metal burnt away, and the iodide remained undecomposed. MM. Bodart and Jobin operated according to the same theory, only instead of using potassium they used sodium, which would have led to the same result had they not had the precaution to use an iron crucible with a lid screwed down tight. This apparently irrelevant circumstance has not only been sufficient to determine the defined reaction, but, as M. Dumas observes, has laid the foundation of a new method for attempting the reduction of the other alkaline metals, or for improving the processes already known.

COLORIFIC LICHENS.

MR. J. BEDFORD has observed to the British Association, that these weeds, although apparently finding their necessary home near the coast, have been discovered by Dr. Livingstone in his recent travels, five hundred miles inland, on the banks of the river Leeva. The paper was illustrated by some beautiful experiments, by a simple extemporaneous test, by which a vivid red and a very rich violet colour were produced.

Mr. Calvert stated that the powerful and soft violet or purple colour that had just been obtained, and which was called, from its fugitive character, *ladies' despair*, had just been successfully fixed by a silk-dyer at Lyons, who, after five or six years' trial, had obtained a permanent dye. He had himself tested it, and the colour remained perfectly fast. Worsteds, wool, cotton, &c., had been submitted successfully to similar tests.

A NEW COLOURING MATTER.

IN a communication addressed to the French Academy of Sciences, M. Verdeil announces the discovery of a green substance extracted *from the flowers* of plants, and quite distinct from the green of their *leaves. It is* well known that the extremities of the petals of a

flower, by which they adhere to the calyx, are white; in buds they are whiter still, and particularly in the flower of the thistle. If this white part be boiled in water, and then subjected to pressure, the juice obtained will be colourless, and remain so in contact with the air; but if a few drops of a solution of carbonate of soda or limewater be added, the surface of the liquid will gradually assume a green colour, and if it be well shaken, the whole will become dark green. If there be an excess of alkali, the green will acquire a yellowish tint; in that case a little acetic acid will transform it into a bluish green. Alum, the acetate of lead, and the deutoxide of tin, precipitate fine green lakes of different shades from the liquid. These lakes, being separated by filtration, and dried, maintain their colour, and resist the influence of light. The protoxide of tin forms a yellow precipitate, and also changes to yellow the green lakes obtained with alum and the acetate of lead. In order to insulate the colouring principle, the lake obtained with acetate of lead is decomposed by sulphuric acid diluted with much alcohol at 40° of Beaumé; the colouring principle is dissolved by the alcohol, while the lead combines with the sulphuric acid. The liquid is then filtered and heated with ether, which precipitates the colouring principle. On being collected on a filter, washed with water, and dried, it is found to be of a yellowish brown; it does not melt, but is decomposed by heat; it cannot be sublimated, but will burn away, leaving some slight traces of ashes. It is insoluble in water and in acids, not very soluble in alcohol, but is very easily dissolved in alkalies, to which it communicates a green colour. An excess of acetic or hydrochloric acid will turn the colour into red and precipitate it. Concentrated sulphuric acid dissolves the colouring principle, and gives it a brilliant red colour. This colouring matter has great affinity for the aluminous mordants fixed on cotton, but it does not directly dye either silk or wool. M. Verdeil concludes by saying that our thistles and artichokes are not sufficiently rich in this colouring principle to admit of its being used as a dye on a large scale, but that those of the warmer climates most probably contain this substance in larger quantities.

SOLID INK.

M. Leonardhi, of Dresden, has invented an ink which he calls "Alizarine Ink," which he can form into cakes for convenience of transport. Liquid inks, hitherto formed into cakes by drying and evaporating, cannot be brought back to the liquid state again satisfactorily. The inventor takes forty-two parts of Aleppo galls, and three parts of Dutch madder, and infuses them in a sufficient quantity of hot water. The solution is then filtered, and five and a-half parts of sulphate of iron are dissolved in it, after which two parts of acetate of iron, and one and one-fifth part of liquid sulphate of indigo are added. The whole is then evaporated to dryness, and the residuum is *moulded into* cakes.

One part of this dry ink dissolved in six parts of hot water gives,

says the inventor, an ink of first-rate quality, but one of good quality may be obtained by employing ten or fifteen parts of water to one of solid ink.—*Journal of the Society of Arts.*

REMOVING FRESCOES.

It has become a habit in Italy to remove Frescoes of interest, for sale or for preservation in public museums. The method adopted is to apply upon the face of the painting a linen cloth, covered with a kind of glue. The "intonaco," or prepared plaster, is then carefully detached from the wall with a knife. The rough surface having been rubbed down with a pumicestone, until the lime is reduced to the thinnest state consistent with the preservation of the painting, a canvas is fastened to the back, and the cloth in front is removed. When this operation is skilfully performed, the detached fresco may almost be treated like a common oil picture. But there is great danger of injuring the painting, especially if it has been finished in tempera, as was the custom of the painters of the end of the fifteenth and beginning of the sixteenth century; whilst the parts in "buon fresco" remain, the subsequent touches are destroyed. The same thing occurs when frescoes are cleaned, as it frequently happens, in a careless and ignorant manner.—*Quarterly Review.*

PRODUCTION OF ORGANIC BODIES WITHOUT THE AGENCY OF VITALITY.

Professor Frankland has read to the Royal Institution, a paper on this subject. He states that the earlier researches of chemists brought them into contact with two classes of bodies distinguished from each other by well-marked peculiarities. One of these classes was met with in the inanimate or mineral kingdom, the other was found exclusively in the animate portion of creation; and as chemists at that time knew of no process by which the elements composing these bodies could be made to unite, these substances were from their origin termed organic bodies or organic compounds, and were regarded as dependent upon what is called vital force. In 1828, however, Wohler produced *urea* artificially, a body till that time known only as a product of organism. This discovery was succeeded by the artificial formation of acetic acid by Kolbe, who also subsequently produced methyl from acetic acid: thus the barrier was broken through which had hitherto separated organic and inorganic bodies, and although the term organic was retained, it was no longer strictly applicable. The recent researches of M. Berthelot have greatly extended this branch of chemical inquiry, who produced chloride of methyl and the members of the olefiant gas family up to amylene, phenylic alcohol and naphthaline, phenyl-carbonic acid and glycerine. These substances, with their derivatives, yield upwards of 700 distinct organic compounds produced from their elements without the agency of vitality.

It has long been known that, with some slight exceptions, the *only materials* employed by nature in the construction of the most *complex* organic compounds are—carbonic acid, water, ammonia,

and nitric acid; but, confining attention on the present occasion to the consideration of carbonic acid only, Professors Kolbe and Frankland were led to the following results:—"1. The replacement of one atom of oxygen in carbonic acid by hydrogen or its homologues produces an organic acid either of the fatty or of the aromatic series, as acetic acid or benzoic acid. 2. The like replacement of two atoms of oxygen in carbonic acid produces either acetone or analdehyde, or oil of bitter almonds. 3. The like replacement of three atoms of oxygen in carbonic acid produces vinic ether. 4. The like replacement of all the atoms of oxygen in carbonic acid produces ethyl, hydride of methyl, or methyl-ethyl." The verification of these views was reserved for Mr. Wanklyn, "who, in his newly-discovered sodium and potassium compounds of the organic radicals, came into possession of re-agents which cannot fail to enable us greatly to increase the number of organic compounds capable of being procured from their elements without the intervention of vitality." Of the bodies hitherto thus produced, alcohol, glycerine, and sugar are undoubtedly the most interesting. Owing to the part they take in the nutrition of animals, they prove the possibility of artificially producing an important part of the food of man; and should the chemist also thus succeed in forming the nitrogenous constituents of food, man might then support life without animal or vegetable food if provided with the necessary apparatus and inorganic materials. We have, however, as yet no clue to the formation of these nitrogenous constituents, and the present prospects of rivalling vital processes in the economical production of staple organic compounds are very slight. But this branch of chemistry is at present in its merest infancy, and it would be rash to pronounce their ultimate realization impossible, as many analogous substitutions of artificial for natural processes have been already achieved.

NEW ORGANIC COMPOUNDS.

Mr. B. C. Brodie, Professor of Chemistry, has made to the Ashmolean Society at Oxford, a communication on a New Series of Organic Compounds, some of the terms of which he has succeeded in forming. These are the peroxides of the radicals of the organic acids, and stand in the same relation to those acids that the peroxide of hydrogen does to water. Mr. Brodie has prepared three of these compounds, namely, the peroxides of benzoyle, cumenyle, and acetyle. The two former are white crystalline solids; the last an oleaginous liquid. The peroxide of acetyle has many properties resembling that of hydrogen; for instance, it possesses a powerful bleaching action: it is also a somewhat unstable body, and at a high temperature explodes with great violence. It also peroxidizes instantaneously the protoxide of manganese.

NITROGEN.

A paper has been read to the British Association, "On the Annual Yield of Nitrogen per Acre in Different Crops," by Mr. J. B. Lawes and *Dr. J. H. Gilbert*. In a paper given at the Dublin Meeting,

in 1857, on the question of the assimilation of free nitrogen by plants, and some allied points, the authors had stated in general terms that the amount of nitrogen yielded per acre per annum in different crops, even when unmanured, was considerably beyond that annually coming down, in the forms of ammonia and nitric acid, in the yet measured and analysed aqueous deposits from the atmosphere. The investigations then referred to were still in progress; and a desirable introduction to the record of the results would obviously be to illustrate, by reference to direct experiment, that which had been before only assumed regarding the yield of nitrogen in our different crops. To this end had been determined the annual produce of nitrogen per acre, in the case of various crops, which were respectively grown for many years consecutively on the same land; namely, wheat, fourteen years; barley, six years; meadow hay, three years; clover, three years out of four; beans, eleven years: and turnips, eight years. In the majority of the instances referred to, the yield of nitrogen had been estimated, both for the crop grown without manure of any kind, and for that with purely mineral manure—that is, excluding any artificial supply of nitrogen. It was the object of the present communication to give a summary view of some of the facts thus brought to light. Beans and clover were shown to yield several times as much nitrogen per acre as wheat or barley. Yet the growth of the leguminous crops, carrying off so much nitrogen as they did, was still one of the best preparations for the growth of wheat; whilst fallow (an important effect of which was the accumulation within the soil of the available nitrogen of two years into one), and adding nitrogenous manures, had each much the same effect in increasing the produce of the cereal crops. Other experimental results were adduced, which illustrated the fact, that four years of wheat, alternated with fallow, had given as much nitrogen in the eight years as eight crops of wheat grown consecutively. Again, four crops of wheat, grown in alternation with beans, had given nearly the same amount of nitrogen per acre as the four crops grown in alternation with fallow; consequently, also, much about the same as the eight crops of wheat grown consecutively. In the case of the alternation with beans, therefore, the whole of the nitrogen obtained in the beans themselves was over and above that which was obtained, during the same series of years, in wheat alone,—whether it was grown consecutively, or in alternation with fallow.

Interesting questions arose, therefore, as to the varying sources, or powers of accumulation, of nitrogen, in the case of crops so characteristically differing from one another as those above referred to. It had been found that the leguminous crops, which yielded in their produce such a comparatively large amount of nitrogen over a given area of land, were not specially benefited by the direct application of the more purely nitrogenous manures. The cereal crops, on the other hand, whose acreage yield of nitrogen under equal circumstances was comparatively so small, were very much increased by the use of direct nitrogenous manures. But it was found that, over

a series of years, only about four-tenths of the nitrogen annually supplied in manure for wheat or barley (in the form of ammonia salts or nitrates) were recovered in the immediate increase of crop. Was any considerable proportion of the unrecovered amount drained away and lost? Was the supplied nitrogenous compound transformed in the soil, and nitrogen in some form evaporated? Did a portion remain in some fixed and unavailable state of combination in the soil? Was ammonia or free nitrogen given off during the growth of the plant? Or, how far was there an unfavourable distribution, and state of combination, within the soil, of the nitrogenous matters applied directly for the cereal crops,—those, such as the leguminous crops, which assimilated so much more, gathering with greater facility, and from a different area of soil, and leaving a sufficient available nitrogenous residue within the range of collection of a succeeding cereal crop?

These questions, among others, which their solution more or less involved, required further elucidation before some of the most prominent of agricultural facts could be satisfactorily explained. Comparing the amount of nitrogen yielded in the different crops, when grown without nitrogenous manure as above referred to, with the amount falling in the measured aqueous deposits, as ammonia and nitric acid, it appeared, taking the average result of the analyses of three years' rain, that all the crops yielded considerably more, and some very much more, than so came down to the soil. The same was the case when several of the crops had been grown in an ordinary rotation with one another, but without manure, through two or three successive courses. Was this observed excess in the yield over the yet measured sources at all materially due merely to exhaustion of previously accumulated nitrogenous compound within the soil? Was it probably attributable chiefly to the absorption of ammonia or nitric acid, from the air, by the plant itself, or by the soil? Was there any notable formation of ammonia or nitric acid from the free nitrogen of the atmosphere? Or did plants generally, or some in particular, assimilate this free nitrogen? As already intimated, some of the points which had been alluded to were at the present time under investigation; the authors having in this the able assistance of Dr. Pugh. Others, it might be hoped, would receive elucidation in the course of time. There of course still remained the wider questions of the original source, and of the distribution and circulation of combined nitrogen in the soil, in animal and vegetable life on the earth's surface, and in the atmosphere above it.

ANIMAL AMMONIA.

A PAPER has been read to the British Association, "On Animal Ammonia: its Formation, Evolution, and Office," by the Rev. J. B. Reade. The author, after referring to the testimony of Brande and Schlossberger as to our ignorance of the cause of the coagulation of the blood, and pointing out the near approach to the solution of the problem by Raspail, proceeds to show that Dr. Richardson, in his *recent work on the subject*, has the undivided and justly-rewarded

merit of proving that coagulation proceeds solely in proportion to the evolution of ammonia.

With reference to his own views on the subject of the paper, the author makes the following observations:—Ammonia, as well as fibrin, exists in the blood, and we have now sufficient, or rather cumulative proof, that the necessary solution of fibrin is caused by the agency of this volatile alkali. It is also equally apparent that a nice adjustment of the quantity of this alkali is indispensable, since an excess, operating beyond the production of fluidity, would tend to dissolve the blood corpuscles themselves, and a defect would be marked by the deposition of fibrin in the heart or arteries. But though ammonia is formed, and that in larger quantities than is required for its primary office and operation, viz., the solution of fibrin, yet the excess is with great care drawn away from the blood, and used where nature requires it. As a gentle stimulant, its presence is required throughout the whole system, and accordingly it enters along with fibrin into the formation of muscular tissues. This I showed many years ago in a paper read before the Microscopical Society of London. It is true that my experiments on the presence of ammonia, *quasi* ammonia, in breath, flesh and animal tissues generally, were received with much caution, or rather, I may say, with hesitation and doubt, and even ocular demonstration failed for a time to remove foregone conclusions; but the existence of ammonia as a normal excrete of the body is now recognised by all parties as an important and undisputed fact, and its power and office as a solvent of the fibrin of the blood is exactly determined.

The primary source and formation of this alkaline solvent, or what leads to its normal development, is a physiological problem yet unsolved. Its elements are well known, but whence derived, or how, or in what part of the body, if in it at all, the chemical combination is effected, are questions which are supposed to point to additional illustrations of the limit of human investigation and reason. Yet that it is absolutely within the body that the formation of the alkaline compound takes place, appears to be capable of proof. For it is quite certain, as the result of repeated experiment, that the ammonia found in the breath,—varying so much in different persons at the same time, and in the same person on different parts of the same day, and especially during the different conditions of rest, exercise, and fatigue,—is not the mere return of the minute portion inspired with the air. And if the air, when charged with its uniform small quantity, fail so manifestly in supplying even the ammonia of the breath, it must of course be rejected as the source of that additional quantity which at the same time is found in every part of the body.

The source and formation of this alkali, therefore, is not *ab extra*. It seems, perhaps, probable that animal ammonia is formed initially in the blood, of which the two leading ingredients, albumen and *fibrin*, are equally rich in *nitrogen*; for this element exists in albumen, according to the analysis of Gay-Lussac, in the proportion of 15·7 per cent., and of 19·9 per cent. in fibrin; while hydrogen, the

other element of ammonia, is in the proportion of 7 per cent. in each. The elements of the alkali, therefore, are present, and are partly used for the formation of substances which are products of subtle chemical action. Now, in the vegetable kingdom, the combination of these elements for the formation of vegetable ammonias is a common and recognised phenomenon; and similarly,—to extend the views of Dr. Richardson,—in the exquisite balance of the chemical forces in the blood, it is arranged that the blood should be feebly alkaline from fixed alkali or alkaline salt; not sufficiently alkaline to hold fibrin in solution, but sufficiently so to leave the volatile alkali free for this purpose, when formed in the closed chambers of the circulation.

I am, therefore, less disposed than my friend Dr. Richardson to leave this point an open question, but rather to meet his inquiry, where is ammonia first formed? with the reply, in blood itself. It is with some satisfaction I can add, that Dr. Richardson himself gives his *imprimatur* to this theory. If this view, then, be anything like an accurate statement of the chemistry of nature, it confirms and harmonizes with the fact, that the formation of ammonia is a continuous process. The portion which maintains fluidity at a given moment does not remain to exercise this office for hours or days, but its evolution direct from the blood is as necessary and continuous an act as its formation. Hence it passes along with fibrin—in fact carries the fibrin, as its solvent, to every part of the body, to supply its daily waste; and having performed this office, and satisfied every other demand, the excess is evolved, in consequence of its equal diffusion, from every excretory surface, and very largely, as I have heretofore proved, from the surface of the lungs in the expired air of the breath.

The evolution of ammonia from the surface of the body may be proved by an interesting experiment which happens not to have found a place in Dr. Richardson's admirable list of 400 save one. If a glass vessel, of suitable shape, having its inner surface just moistened with hydrochloric acid, be placed on any part of the body when warm with exercise, and therefore in a slight state of perspiration, evolved ammonia will be taken up by the acid; and if collected in a little distilled water, the hydrochlorate may be received and crystallized by evaporation on a slip of glass for the microscope. The same experiment may also be performed on the bodies of horses and other animals.

The general experiments which prove the existence of ammonia in breath are now too well known to need description; but there is a new experiment of considerable importance, as confirming the proof of these two propositions—that there is a volatile alkali evolved in the breath, and that this alkali, having the property of maintaining the fluidity of the blood, is ammonia. Dr. Richardson has proved that in the experiment of passing the vapour of blood through blood, coagulation is suspended by the agency of a volatile principle, and he has also proved by experiment that this volatile principle is *ammonia*. Now, the vapour of blood is a large constituent

of the vapour of breath, and the effect of passing this latter vapour through blood is precisely similar to that of the former. If a portion of blood be received in a vessel, and the expired air and vapour of breath, collected in quantity and in a suitable apparatus, be passed through it, the fluidity of the blood is maintained so long as the experiment is continued; thus furnishing a proof of the escape of a volatile agent in the breath, which agent by direct experiment upon it is proved to be ammonia. This experiment is in all respects most satisfactory. Had it failed, the whole subject would again be enveloped in its ancient mystery, and we should say with Brande that the cause of coagulation is still unexplained. True, we should know that the vapour of blood sustains fluidity, and that its volatile alkali, ammonia, sustains fluidity also; but so do the fixed alkalis, potash and soda, which are proved to be inoperative as the cause of coagulation.

If then the vapour of breath, which is characterized by the same volatile agent as the vapour of blood, failed to prevent coagulation, we must unavoidably be led to the conclusion that, notwithstanding the evidence of experiment in a given direction in favour of ammonia, there is a still more subtle agency at work, even during the evolution of this alkali from newly-drawn blood, which is the true and ultimate cause of coagulation. Ammonia, like potash and soda, would then be looked upon as a mere proximate agent in sustaining fluidity, and its evolution would cease to be acknowledged as the final and efficient cause of coagulation.

ABSORBENT POWERS OF SOILS.

DR. DAUBENY has read to the Chemical Society, a communication he had received from Baron Liebig, relating to the Absorbent Powers of Soils. Baron Liebig maintained that the spongioles of plants, in obtaining their supply of saline matter, did not act by simple absorption, but exerted a real decomposing action upon certain ill-defined compounds which the saline matter formed with the insoluble constituents of the soil. Dr. Daubeny also referred to the ammoniacal emanations from volcanoes, and suggested that they might arise from the aqueous decomposition of certain nitrides, such as the nitride of boron, and the nitride of titanium.

PATENT SEWAGE MANURE.

MR. J. A. MANNING, of the Inner Temple, who has devoted much time and study to the Sewage Manure question, and patented several inventions connected with it, has completed a further patent for the manufacture or production of Manures or fertilizing agents from Sewage Liquors, in combination with the dry wastes of towns. The patentee proposes to collect the sewage flow in suitable tanks or reservoirs, and there mix it, for the purpose of precipitating the solid matters with alum sludge, or its chemical equivalents. The supernatant and clarified liquid is then permitted to flow off, and may be advantageously employed for the irrigation of land. The remaining solid or semi-fluid matter resulting from the treatment is

then deposited in a suitable receptacle, and mingled with the dry wastes or refuse of towns, including refuse matter from manufactories, and all those matters contained in the house, dust-bins, pits, &c., such as ashes, decayed refuse vegetable matter, fæcal matter, and also, if found advantageous, the sweepings, droppings, and offal of roads, streets, and markets, and other refuse matters of a fertilizing nature, which do not form a part of the ordinary sewage discharge. To facilitate the formation of this mixture into matter sufficiently solid for carting, the refuse matters, before being added to the sewage, may be more or less ground or pulverized if found desirable. By this means a solid, easily portable fertilizer of great agricultural value will be obtained.—*Mechanics' Magazine*, No. 1830.

THE THAMES WATER.

During the summer of the past year, great apprehension was excited in the Metropolis by the impure state of the River Thames, aggravated by two causes—the sewage of London daily flowing into it, and the accumulation of sewage in the form of mud along its banks; and the extraordinary heat of the weather, the thermometer having risen, at the close of June, to the height of 94·5 degrees in the shade. We have not space to detail the measures which were taken, or the suggestions, remedial and preventive, for staying this frightful evil. A Committee of Parliament, appointed to report upon Mr. Gurney's plan for the purification of the Thames, received a large amount of evidence and advice from various engineers of eminence; and much valuable experience was collected in the examination of the various plans of Drainage, the proposed remedy; as well as in the evidence of the medical authorities. From the latter we quote the following explanation of the extraordinary state of the River in June last, by Dr. Letheby, in his Quarterly Report on the Health of the City of London, presented to the City Commissioners of Sewers, dated July 6, 1858:—

The high temperature of the last month (June), together with the continued absence of rain, has caused the Thames to assume an appearance and to undergo a change which has never before been witnessed. I have been engaged for the last fortnight in making daily examinations of Thames water at different points between Teddington-lock and Greenwich, and the results of these examinations are that the river is unusually charged with sea-salt and organic matter. The oceanic tide in the river has risen as high as Wandsworth, and has thus contaminated the water with saline and other impurities of the sea. As a rule, the soluble inorganic constituents of the river do not exceed 45 grains in the gallon at high tide at London Bridge, and the organic impurity is not more than 4 grains in the gallon; but during the last fortnight the saline elements have amounted to 131 grains in the gallon, and the organic to 12. Even at Westminster Bridge, they have reached to 69 grains per gallon, and the organic matter to 5·6. The proportions at other places at high and low tides are given in the fifth table of the Appendix, and they show that the sea-water has risen to a great height in the bed of the river. Now, all experience proves that whenever such a mixture as this occurs at high temperature, putrefaction of a most offensive character is set up. The sewage and the organic matter, and sulphates of the sea-water, have acted on each other, and have produced the state of things with which, for the last fortnight, we have been so familiar. The inky appearance of the river has been caused by the fixation of the *sulphuretted* hydrogen by the iron of the clay. This has been the *salvation of our lives, for* offensive as has been the vapour evolved from the river,

it is as nothing in comparison with what it would have been if the much-abused clay from the lower shores of the river had not fixed the miasm in a solid, involatile form. As it is, however, the gases evolved from the water amount to about 15 cubic inches per gallon. They consist chiefly of carbonic acid with ammonia, nitrogen, and a trace of oxygen. They do not contain sulphuretted hydrogen, but they contain a stinking vapour which is in the highest degree offensive, and which inhaled produces slight headache, giddiness, and nausea. The water at midstream is charged with the higher forms of animal and vegetable infusorial life; but that at the shore is so lethal in its qualities, that nothing exists in it but the lowest forms of fungi and the simplest of living creatures.

With all this condition of the Thames, however, the health of the metropolis has been remarkably good, and the fact is illustrated not merely by the mortality returns, but also by the still more significant returns of sickness. In the corresponding period of last year, the cases of fever, diarrhœa, and dysentery attended in the City by the medical officers of the unions amounted to 293 of the former and 181 of the latter; but during the past quarter they were only 202 of the former and 94 of the latter. It may be thought, perhaps, that as the City is only a small section of the metropolis, it does not represent the condition of the whole; but returns have been collected by the medical officers of health throughout the whole of the capital, and those, like the last, show a great falling off in the proportion of zymotic disease. In the twelve weeks of last year there were nearly 80,000 cases of sickness returned, and during the present period returns have been more fully obtained, and they embrace as many as 114,000 cases of sickness. Of the former, the proportion of fever cases amounted to 22·4 per 1000, and of diarrhœa and dysentery to 40·5; but of the latter, the proportions are 16·2 and 25·1.

I am not in a condition to account for these remarkable facts. It may be that the prevailing winds of the season have diluted the miasm, and have wafted it quickly away from the more densely populated parts of the City; or it may be that the unusual amount of ozone in the air has exerted its beneficial influence by oxidizing the organic poison; or it may be that the strength of the human system after the bracing influence of winter has been sufficient to resist the morbific action of the malaria; or it may be, as some have said, that, offensive as is the stink of the vapour, it has no lethal action on the animal system, for, to use the words of a reviewer in one of the medical journals, "there is no necessary connexion between bad odours and poisonous miasms; for we find that some of the most pestilential places in the world, such as the mouths of certain African rivers, the sunderbunds of the Ganges, the Pontine Marshes, and our own fens, give no evidence of a poison by their odour; while conversely we may have an atmosphere charged with the most horrid stinks without its being dangerous to health, or, at any rate, productive of fevers, &c." My own opinion is, that the effects of the Thames vapours have been warded off by the healthy and vigorous condition of the body at this season of the year; and that if the putrid miasms come to operate upon us during the autumn, when the vital powers are exhausted and the animal frame relaxed by the heat of summer, the effects may be very serious.

SULPHURETTED HYDROGEN IN THAMES WATER.

Dr. Medlock has communicated to *The Builder*, the following result of some experiments he has recently made with the view of deciding the much-vexed question regarding the existence or non-existence of Sulphuretted Hydrogen in the Water of the Thames.

When we bear in mind the enormous quantity of sewage, rich in sulphur compounds, which daily flows into the river, it will be evident that much sulphuretted hydrogen must be present, although, strange to say, several eminent analysts have failed to detect it by chemical tests, and have consequently denied its existence.

Recently, I have collected several samples of Thames water from the pier of Hungerford-bridge. In each specimen I recognised sulphuretted hydrogen, but the quantity in the samples varied considerably. The method adopted for detecting this gas was as fol-

lows:—A pint of water was introduced into a glass flask, over the mouth of which was placed a piece of white blotting-paper, moistened with acetate of lead. On gently heating the water, the test paper became in a few minutes discoloured by the sulphuretted hydrogen expelled, but the depth of colour imparted to the paper differed very remarkably: in some, the colour was a light brown; in others, almost black. This variation of colour was due, as subsequent experiments proved, to the degree of *agitation* to which the water was exposed previously to analysis. If a bottle was only *partially* filled, the shaking of the water in its carriage from the river to the laboratory expelled nearly every trace of gas, and on removing the stopper it escaped; but in bottles *quite* filled and well stoppered no agitation could take place, and consequently the gases remained in solution. This may perhaps explain why several chemists have recently failed to detect sulphuretted hydrogen in Thames water.

Having noticed this peculiar circumstance, it appeared important to determine the *rapidity* with which sulphuretted hydrogen is expelled from water by agitation. To this end I prepared a quantity of sulphuretted hydrogen water, containing in each imperial pint 14·72 cubic inches of gas, at 60 degrees Fahrenheit.

A pint of this solution gently stirred in an open glass beaker for five minutes lost 11·57 cubic inches, and retained 3·15 cubic inches.

A second pint, stirred for ten minutes, lost 13·95 cubic inches, and retained 0·77 cubic inch.

A third pint, stirred for twenty minutes, lost 14·29 cubic inches, and retained 0·43 cubic inch.

A fourth pint, stirred for half an hour, retained only sufficient sulphuretted hydrogen to impart, when heated, but a very slight colouration to lead paper. The above experiments were made in a room of a temperature of 63° Fahr. At a higher temperature, the escape of the gas is much more rapid and complete.

During the recent hot weather, the water of the Thames has attained a temperature of from 70° to 75°; and as the slightest agitation of the water at this temperature will cause the expulsion of nearly all the sulphuretted hydrogen it receives from the sewers, your readers may form some idea of the extent to which the atmosphere near the river has been recently contaminated.

I have made an extensive series of experiments with other gaseous products of the decomposition of animal matter; but as the details would occupy too much of your valuable space, I will confine myself to mentioning the important fact, that of all the gases which are soluble in water, more than nine-tenths of the quantity of gas held in solution is expelled by ten minutes' agitation.

MORRELL'S DISINFECTING FLUID.

THIS very useful Disinfecting and Deodorizing Fluid is a highly concentrated solution of chloride of zinc, which is certainly preferable to chloride of lime in all cases where the corrosive power or strong odour of the latter are objectionable, as in sick rooms, or

indeed in dwellings generally. The chloride of zinc is comparatively inoffensive as regards smell or corrosive vapours, and has been proved at the same time to act as a powerful disinfectant. It appears to be now in very general use in her Majesty's service, and in passenger and merchant ships, &c.

AIR OF TOWNS.

DR. ANGUS SMITH has read to the Chemical Society a paper "On the Air of Towns." The author had not been able to detect ozone in the air of Manchester, but at some little distance it was easily recognisable when the wind was not blowing from the town. The air of Manchester was always acid, and the rain-water so acid as immediately to redden litmus infusion. Dr. Smith employed permanganate of potass as a reagent for estimating the amount of organic matter in the air. Among other results, he found that a definite amount of a standard solution of the salt was decolourized by 22 measures of air from the high ground in the neighbourhood of Preston, by 9 measures of air from an open street in Manchester, by 5½ measures of air from between some small houses on the banks of the Medlock river, by 2 measures of air from a closed carriage of passengers, and by 1 measure of air from the backyard of a house in a low and closely-built neighbourhood. A very noticeable difference was observed when blood was agitated with different varieties of air. Contrary to expectation, the air of the town was found to exert a greater reddening effect than the air of the sea-shore.

OZONOMETER.

DR. LANKESTER has exhibited to the British Association an Instrument for Measuring the Constant Intensity of Ozone. This ozonometer consisted of two small rollers included in a box, which were moved by means of ordinary clockwork. Over the roller a strip of paper, prepared with iodide of potassium and starch, is allowed to revolve, the paper becoming exposed to the air for an inch of its surface in the lid of the box. Twenty-four inches of paper pass over the rollers in the course of the twenty-four hours, and thus registers, by its colour, the intensity of the action of ozone in the atmosphere. By this instrument the intensity of the ozone for every hour in the twenty-four could be registered, and *minima* and *maxima* with an average be ascertained. The register of ozone could also be compared with those of the anemometer, and the relation of ozone to the direction and force of the wind ascertained. Dr. Lankester pointed out the importance of ascertaining the presence of ozone, on account of its undoubted relation to health. He drew attention to a series of tables which had been drawn up from the registrations of the anemometer made at London, Blackheath, and Felixstow, on the coast of Suffolk. From these it was seen that the relation of these three places was as 0, 22, and 55. The instrument acted also as a clock, and the time could be accurately marked upon the ozonized paper.

Mr. Marshall made some remarks on his own observations during

the last twelve months, and stated that he had not been able to discover, though assisted in the investigation by medical gentlemen, that there was any obvious connexion between ozone and the state of health.

DEODORIZING AND DISINFECTING PROCESS.

MESSRS. CONDY have, at their Chemical Works at Battersea, made some experiments with their Disinfecting Fluid, which consists of solutions of manganate, or per-manganate of soda or potash —salts which, in consequence of their containing and emitting with facility a large quantity of oxygen, are peculiarly applicable to purposes of disinfection and deodorization. Used as a test of the purity of water, these results were obtained—that while distilled water assumed and retained to a great extent the purple colour of the fluid when mixed with it, the presence of organic matter was indicated in the case of spring and less pure water by the rapid decolourization of the disinfecting substance. The action of the fluid as a test of the comparative purity of different waters having been thus ascertained, its operation as contrasted with that of lime, which has been used at an expense of 1500*l.* per week to obviate the stench arising from the Thames, was shown by the following process. Two large glasses were filled with sewage water emitting a most offensive odour, that in one of the glasses being subjected to the action of lime, while into the other a small quantity of the disinfecting fluid was poured. Both those substances operated effectually as precipitants, but it was alleged that, whereas in the case of the former deodorization simply had taken place, in the case of the latter actual disinfection had been produced, owing to the fact that the organic impurities contained in the water which had been subjected to its influence had undergone a process of combustion, and that the cause of the odour or putrefaction had in consequence been permanently removed, instead of being merely temporarily disguised.

In illustration of this view, the test of its capability to retain the colour of the disinfecting fluid was applied to the water in each of the glasses, when the continued presence of organic matter in that which had been treated by lime, and the absence of such matter in the instance in which the fluid had been used, would appear to be established by the decolourization in the one case, and the retention of the colour in the other case, of the disinfecting agent. The result of the application of such an agent at the various outlets of the sewers running into the Thames would be, in the opinion of the patentees, to obviate a nuisance which has now assumed so serious a character. It is admitted that the process would involve a considerably larger outlay than would be necessary in the case of lime; but then the Messrs. Condy contend that that outlay would be more than counterbalanced by the value of the deposit which would be created under the operation of their scheme, and which they say would retain all its fertilizing properties, while that created under the action of lime had been proved by experience to be completely

worthless as a fertilizing agent. Nothing, it may be added, could be more complete than the success of the fluid in rendering the impure water upon which it acted clear and devoid of all offensive odour. How far it would tend to solve the great Thames problem it is for the proper authorities to determine.—*Times' Report.*

THE PRESERVATION OF THE DEAD.

THE process patented by M. Falcony, a French chemist, for Embalming and Preserving Dead Bodies, though it has for several years been in use in some of the principal cities on the continent, has but recently been introduced into this country, and even yet it is little known, if at all, beyond the limits of the medical profession. It is probable, however, that the highly successful result of an experiment which took place recently at the Grosvenor School of Medicine will not only establish its efficiency among the medical authorities of London, but will lead to its general use throughout the country. The preparations of M. Falcony are of two kinds—one, a fluid, intended to preserve the body from decay for an indefinite period; and the other a powder, designed to prevent decomposition for a considerable time, or to arrest active putrefaction if it have already commenced. Both processes were subjected to a minute examination, but it was to the latter, as being of greater importance and utility than the other, that attention was chiefly directed. The subject of the experiment was the body of a man who died of erysipelas on the 21st of September. It was taken to the school on the 24th in an advanced stage of putrefaction, the head and face being greatly swollen and discoloured. The trunk was also much decayed, and it was pronounced by Dr. Halford, the lecturer on anatomy, to be totally unfit for dissection.

On the following day, the 25th, M. Falcony commenced his operations, which were conducted in the presence of several gentlemen of considerable professional eminence. He covered the bottom of the coffin with his powder to the depth of about three inches; on this the body was placed, and then covered over with the antiseptic powder mixed with sawdust as a vehicle. In about ten minutes not a trace of the offensive smell remained, and when the body was uncovered, after the lapse of between three and four weeks, it was found to be in the same condition as when it was put into the hands of M. Falcony. The powder had arrested the putrefaction, and none of those present were sensible of any unpleasant odour. A hand, into which a small quantity of the fluid intended for the permanent preservation of the dead had been injected some weeks, was also produced. The skin still remained white, and no smell was emitted, although the hand had been placed in water and subjected to other conditions favourable to decomposition. Dr. Halford congratulated M. Falcony on the successful result of his experiments, which proved that his invention was of the highest value, and might be made extremely beneficial in a sanitary point of view. M. Falcony delivered a short address in French, in which he referred to the cordial reception he had met with in England, and expatiated

upon the advantages which his discovery was calculated to confer on mankind—in the first place, by the prevention of those innumerable contagious diseases which result from the miasmata emitted from dead bodies in certain cases; secondly, by preserving the remains of deceased persons for the inspection of friends and relatives residing at a distance; and, thirdly, by subserving the purposes of justice in cases of suspected poisoning. He did not pretend, he said, to have brought this interesting department of chemical science to perfection; what he had done would be surpassed by others, but *il faut frayer le chemin*, and in the meantime we ought to avail ourselves of the advantages which society might derive from his studies.—*Times' Report.*

EXPERIMENTS ON DIGESTION.

THE following Notes have been communicated to the British Association by Dr. G. Harley. The communication was illustrated by numerous experiments showing the properties of the saliva, the gastric juice, the bile, and the pancreatic secretion. The author stated that, contrary to an opinion lately published by Bernard, the distinguished French physiologist, he had found that the human saliva contains both sulphocyanide of potassium and iron. The latter substance, however, can only be detected after the organic matters contained in the secretion are destroyed by burning. Dr. Harley had ascertained that a person of nine stone secreted between one and two pounds of saliva in twenty-four hours. The gastric juice, the author says, does not destroy the power possessed by the saliva of transforming starch into sugar; consequently, the digestion of amylaceous food is continued in the stomach. The gastric juice has the property of changing cane into grape sugar. The author made some remarks upon the cause of the gastric juice not digesting the living stomach; and said that his experiments showed that it is not the epithelium lining the organ which prevents its being digested, but the layer of thick mucus which covers its walls. When the latter substance is absent, the gastric juice attacks the walls of the living stomach, and digests them; causing perforation and death. As regards the bile, it seems that this secretion takes an active part in rendering the fatty matters of our food capable of being absorbed into the system. The most curious of all the digestive fluids, however, is the pancreatic secretion, for it unites in itself the properties of all the others. It not only transforms starch and other substances into sugar, but it emulsions fats, and even digests protein compounds. As a remedy in indigestion, pancreatine should be greatly superior to pepsin, which can only digest one kind of food—namely, protein. The author said he had been labouring to obtain pancreatine in a perfectly pure state, and had been, to a certain extent, successful. With pancreatine, we should be able to digest any kind of food we pleased; therefore, the obtaining of it in a state of purity would prove an invaluable boon to suffering humanity.

SUGAR AND THE LIVER.

SOME new facts have been lately brought to light by Dr. Pavy, in his researches into the Sugar-forming Functions of the Liver, discovered by Mons. Bernard, and communicated by him to the French Academy of Sciences. From many experiments made, Dr. Pavy found that the condition of the blood after death cannot be taken as indicating its state during life; for while the fact exists that sugar may be found in the blood after death, if the blood be extracted during life there is scarcely any appreciable amount of sugar to be discovered. The researches of Bernard had taught that a material naturally existed in the liver which was very susceptible of conversion into sugar. Dr. Pavy sought for an agent to check the transformation of this sugar-forming material, and found that potash possessed it without destroying the principles concerned. A strong solution was then injected into the liver through the portal vein immediately after death, when the organ presented scarce a trace of sugar; but a liver thus treated after an interval gave the usual strong reaction of sugar. The sudden abstraction of heat from the liver immediately after death produces the same effect of arresting the production of sugar. Division of the spinal cord, when the weather is cold or temperate, produces a reduction of the temperature: if an animal is killed when thus cooled down to 70°, the liver is found free from sugar. The presence or absence of sugar in the liver of frogs is also dependent on the temperature of the animal at the time of death. Dr. Pavy suggests the name of "hepatine" for this sugar-forming material, instead of Bernard's "glucogenic matter." Now, the amount of hepatine varies according to diet. It is greater under a vegetable than an animal diet, and the amount is increased by the addition of sugar to the animal diet. If hepatine is introduced into the circulatory system, a saccharine state of the blood is induced, and a strongly-marked diabetic condition of the urine may be established. But while these facts have been elicited, it remains yet to be shown how hepatine resists transformation into sugar during life, when it is so rapidly changed at an elevated temperature immediately after death.—*Critic Report.*

BEET-ROOT DISTILLERIES.

MR. F. WEEKES writes from Bolney Lodge, Sussex, June 22, 1858: "The Report of the Commissioners of Inland Revenue shows that on an average their distilleries had not yet been worked three months, nor was either of them now quite finished or perfectly completed; in which state 4895 tons of beet and mangold had been distilled, producing about 40,000 gallons of proof spirit, similar to what the greater part of the French brandy sent to this country is made of. The eminent French distiller, Leplay, is erecting fourteen root distilleries this year for different proprietors in France, to all of whom, and to many others who have carried on the same business for years in that country, I can give you reference. I believe it may attain to great success and benefit here to the public generally, tending to produce a larger supply of both corn and meat, which the

growth of roots will always promote. As one instance under a short trial, some cull South-down lambs I purchased on July 5 last, at 12*s.* 6*d.* each, and sold last week, fatted almost entirely on the steamed roots, at 38*s.* each, after taking a better fleece of wool than usual; nor could I have fatted them so well on any other produce. And in so steaming the roots, is it not better to catch the steam and condense it into spirit than let it go up the chimney to evaporate in the air? It must be better, as paying for the work and supplying as good an article at home for nearly half the price we now pay for the same from France. My stock are now feeding on roots distilled last December, the process being a great preservative of them, on which cows, sheep, pigs, and horses feed greedily, as other agriculturists with similar distilleries fully testify."

ALCOHOLIC FERMENTATION OF SUGAR.

M. Pasteur has observed (*Comptes Rendus*, vol. xlvi. p. 179,) that, in the alcoholic fermentation, a portion of the sugar becomes changed into succinic acid. When the fermented liquid is evaporated, and precipitated with a silver salt, the precipitate decomposed by sulphuretted hydrogen, and the liquid evaporated, the succinic acid is obtained in crystals. The quantity amounts to a half per cent. of the fermented sugar. In wine, also, Pasteur found succinic acid. According to the same chemist, glycerine also invariably occurs among the products of the alcoholic fermentation of sugar; and he estimates its amount at 3 per cent. of the fermented sugar. It is further contained in all fermented liquors, and especially in wine.—*Philosophical Magazine*, No. 108.

MINERAL CANDLES.

The Rev. Mr. Barlow has read to the Royal Institution, a paper "On Mineral Candles and other Products manufactured at Belmont and Sherwood, by Price's Patent Candle Company," according to processes patented by Mr. Warren De la Rue.

1. *The raw material* is a semi-fluid naphtha, drawn up from wells in the neighbourhood of the river Irawaddy, in the Burmese empire. In its raw condition, the substance is used by the natives as a lamp fuel, as a preservative of timber against insects, and as a medicine. It is partly volatile, and is imported in hermetically closed metallic tanks. Reichenbach, Christison, Gregory, Reese, Young, Wiesman (of Bonn), and others, have obtained from peat, and other organic minerals, solids and liquids bearing some physical resemblance to the one procured from the Burmese naphtha; but the first-named products have, in every instance, been formed by the decomposition of the raw material. The process of De la Rue is, from first to last, a simple separation, without chemical change.

2. *The processes adopted.*—In the commercial processes, as carried out by Mr. George Wilson, the crude naphtha is first distilled with steam at a temperature of 212° Fahr., about one-fourth being separated by this operation. The distillate consists of a mixture of many volatile hydro-carbons; and it is extremely difficult to separate them from each other on account of their vapours being mutually very diffusable, however different may be their boiling points. In practice, recourse is had to a second or third distillation, the products of which are classified according to their boiling points or their specific gravities, which range from ·627 to ·860, the *lightest coming over first.* It is worthy of notice, that though all these volatile *liquids were distilled from* the original material with steam of the temperature

of boiling water, their boiling points range from 80° Fahr. to upwards of 400° Fahr.

These liquids are all colourless, and do not solidify at any temperature, however low, to which they have been exposed.* They are useful for many purposes. All are solvents of caoutchouc. The vapour of the more volatile, Dr. Snow has found to be highly anæsthetic. Those of the lower specific gravity, called in commerce *Sherwoodole*, have great detergent power, readily removing oily stains from silk, without impairing even delicate colours. The distillates of higher specific gravity are proposed to be used as lamp-fuel; they burn with a brilliant white flame; and, as they cannot be ignited without a wick, even when heated to the temperature of boiling water, they are safe for domestic use.

A small per centage of hydro-carbons, of the benzole series, comes over with the distillates in this first operation. Messrs. De la Rue and Müller have shown that it may be advantageously eliminated by nitric acid. The resulting substances, nitro-benzole, &c., are commercially valuable in perfumery, &c.

After steam of 212° has been used in the distillation just described, there is left a residue, amounting to about three-fourths of the original material. It is fused, and purified from extraneous ingredients (which Warren De la Rue and H. Müller have found to consist partly of the colophene series) by sulphuric acid. The foreign substances are thus thrown down as a black precipitate, from which the supernatant liquor is decanted. The black precipitate, when freed from acid by copious washing, has all the characteristic properties of native asphaltum. The fluid is then transferred to a still, and, by means of a current of steam made to pass through heated iron tubes, is distilled at any required temperature. The distillates obtained by this process are classed according to their distilling-points, ranging from 300° to 600° Fahr. The distillations obtained, at 430° Fahr. and upwards, contain a solid substance, resembling in colour and in many physical and chemical properties the paraffine of Reichenbach; like it, it is electric, and its chemical affinity is very feeble: but there are reasons for believing that a difference exists in the atomic constitution of the two substances. The commercial name of *Belmontine* is proposed for the solid derived from the Burmese naphtha. Candles manufactured from this material possess great illuminating power. It is stated that a Belmontine candle weighing $\frac{1}{8}$th lb., will give as much light as a candle weighing $\frac{1}{6}$ lb. made of spermaceti or of stearic acid. Its property of fusing at a very low temperature into a transparent liquid, and not decomposing below 600° Fahr., recommends this substance as the material of a bath for chemical purposes. As to the fluids obtained in the second distillation, already described, they all possess great lubricating properties; and, unlike the common fixed oils, not being decomposable into an acid, they do not corrode the metals, especially the alloys of copper, which are used as bearings of machinery. This aversion to chemical combination, which characterizes all these substances, affords not only a security against the brass-work of lamps being injured by the hydro-carbon burnt in them, but also renders these hydro-carbons the best detergents of common oil-lamps. It is an interesting physical fact, that some of the non-volatile liquid hydro-carbons possess the fluorescent property which Stokes has found to reside in certain vegetable infusions.

3. *Chemical constitution of these hydro-carbons.*—On this subject, there will be found a short memoir by Warren De la Rue and Hugo Müller, in the Proceedings of the Royal Society, vol. viii., page 221. The researches referred to in that memoir are nearly completed. The principal constituents of the Burmese naphtha are—(*a*), (the largest in proportion) a substance identical in composition with either the hydurets or the radicals of the ethyle series; (*b*) substances of the benzole series forming a comparatively small portion. It has, however, been ascertained that some of the hydro-carbons of this aromatic series differ in their chemical and physical properties from the analogous members of the same series obtained from the usual sources. This difference is most strongly marked in the case of cumole and its higher homologues of the benzole series,† (*c*) the colophene series already adverted to.

An important characteristic of the Burmese naphtha is its being almost entirely destitute of the hydro-carbons belonging to the olefiant-gas series.

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* *The freezing* mixture of solid carbonic acid and ether does not affect the fluidity *of these bodies.*

† *In illustration* of this view may be cited, Church's discovery of a parabenzole *[c]oal tar, boiling* at 185° Fahr., and not solidifying at 32°.

NEW OIL FOR PURE WHITE LIGHT.

PRICE'S Patent Candle Company have prepared "Belmontine Oil," which they believe to be the cheapest artificial source of Pure White Light. At the late Meeting of the British Association, at Leeds, Mr. Warren De la Rue exhibited, in an improved Reflecting Stereoscope, (made by Smith, Beck, and Beck,) his splendid 8-inch Lunar Photographs, after a series of trials, illuminating them with Belmontine Oil in a new Argand lamp, made by Tylor and Sons. These views of the Moon surpassed any object previously exhibited, to which the beauty, constancy, and purity of the light materially contributed. The Belmontine Oil will also burn in some of the lamps used for paraffine, and even in some of the old camphine and Vesta lamps.

COMPOSITION FOR DESTROYING THE RED SPIDER, MILDEW, ETC.

MR. G. F. WILSON (manager of Price's Candle Company,) has succeeded in discovering an effectual remedy for mildew and red spider, wholly free from the objections attaching to sulphur, either in powder or in a volatile state. "How valuable that agent is, (says the *Gardeners' Chronicle,*) we all know; but it is troublesome to apply, uncertain in its action, and, if mismanaged, more mischievous than the evils it counteracts—as, for example, when it is fired, the effect of which is to charge the atmosphere with fumes of sulphurous acid, one of the most fatal to vegetation of all known substances."

The new remedy, named the "Gishurst Compound," is a soap, which, being dissolved in water and applied with a syringe, does effectually and without the least risk all that flowers of sulphur can do. Six ounces of the soap in a gallon of water killed mildew for the time, and continued to keep it down when applied weekly. Pot-roses, after three applications, became nearly clean, and were in fact saved; their soft young points indeed were killed, but that was of no importance; the rust of Moss-roses disappeared before its action. In other hands red spider was effectually kept down; 1 lb. of the soap dissolved in 4 gallons of water completely cleaned even Peach-trees after two or three applications, the trees having been well syringed a day or two afterwards.

It will prevent and destroy red spider, mildew, scale, meal-bug, thrip, and green and brown fly. We have seen testimonies to its efficacy on the most virulent mildew from Mr. Rivers, the extensive rose-grower. Mr. Reicher, the head of the amateur Orchid growers, has succeeded with it admirably in loosening scale; Sir William Hooker has employed it, with great benefit, in Kew Gardens; and Messrs. Dickson, of Chester, have used it and recommended it with equally beneficial effect.

PHOTOCHEMICAL RESEARCHES.

PROF. BUNSEN and DR. H. E. ROSCOE, at the close of a communication to the Royal Society, on "The Optical and Chemical Extinction of the Chemical Rays," give as the conclusion from all their

observations, that the coefficients of extinction of pure chlorine for chemical rays from various sources of light are very different. The depth to which such light must penetrate chlorine at 0° and 0·76, in order to be reduced to $\frac{1}{10}$ of its original intensity, is—

1. For a flame of coal-gas . . . . 173·3 mm.
2. Reflected zenith light, morning . . . 45·6 mm.
3. Reflected zenith light, evening . . . . 19·7 mm.

Hence it is seen that the chemical rays reflected at different times and hours not only possess quantitative but also qualitative differences, similar to the various coloured rays of the visible spectrum. Had nature endowed us with the power of discriminating the chemical rays, as we do the visible ones, by impressions of varying colour, we should see the rosy tints of morning pass in the course of the day through all the gradations of colour until the warm evening ones at length succeed.

A long and continued series of observations must be made before we are able to appreciate the influence which these qualitative differences in the chemical rays exert upon the photochemical phenomena of vegetation. That this influence must be of the greatest importance is evident from the varying effects produced in other photochemical processes by differences in the solar light. We need only mention in proof of this assertion the fact, well known to all photographers, that the amount of light, photometrically speaking, gives no measure for the time in which a given photochemical effect is produced, and that a less intense morning light is always preferred for the preparation of pictures to a bright evening light.

Sir John Herschel, in his Address as President of the Chemical Section of the British Association, at their late Meeting, said:

"Hitherto the more attractive applications of photography have had too much the effect of distracting the attention from the purely chemical question which it raises; but the more we consider them in the abstract, the more strongly they force themselves on our notice; and I look forward to their occupying a much larger space in the domain of chemical inquiry than is the case at present. That light consists in the undulations of an ethereal medium, or at all events agrees better in the characters of its phenomena with such undulations, than with any other kind of motion which it has yet been possible to imagine, is a proposition on which I suppose the minds of physicists are pretty well made up. The recent researches of Prof. Thomsom and Mr. Joule, moreover, have gone a great way towards bringing into vogue, if not yet fully into acceptation, the doctrine of a more or less analogous conception of heat. When we consider now the marked influence which the different calorific states of bodies have on their affinities—the change of crystalline form effected in some by a change in temperature—the allotropic states taken on by some on exposure to heat—or the heat given out by others on their *restoration* from the allotropic to the ordinary form (for though I am aware that Mr. Gore considers his electro-deposited antimony to be a *compound*, I cannot help fancying that at all events the state in

which the antimony exists in it is an allotropic one),—when, I say, we consider these facts in which heat is concerned, and compare them with the facts of photography, and with the ozonization of oxygen by the chemical rays of the electric spark, and with the striking alterations in the chemical habitudes of bodies pointed out by Draper, Hunt, and Becquerel; and when, again, we find these carried so far that, as in the experiments of Bunsen and Roscoe, we find the amount of chemical action numerically measuring the quantity of light absorbed—it seems hardly possible not to indulge a hope that the pursuit of these strange phenomena may by degrees conduct us to a mechanical theory of chemical action itself. Even should this hope remain unrealized, the field itself is too wide to remain unexplored, and, to say nothing of discovery, the use of photography merely as a chemical test may prove very valuable, as I have myself quite recently experienced, in the evidence it has afforded me of the presence in certain solutions of a peculiar metal having many of the characters of arsenic, but differing from it in others, and strikingly contrasted with it in its powerful photographic qualities, which are of singular intensity, surpassing iodine, and almost equalling bromine."

PHOTOGRAPHIC PROGRESS.

"PHOTOGRAPHY," said Professor Owen, in his Address to the British Association, "is now a constant and indispensable servant in certain important meteorological records. Applied periodically to living plants, photography supplies the botanist with the easiest and best data for judging of their rate of growth. It gives to the zoologist accurate representations of the most complex of his subjects, and of their organization, even to microscopic details. The engineer at home can ascertain, by photographs transmitted by successive mails, the weekly progress, brick by brick, board by board, nail by nail, of the most complex works on the Indian or other remote railroads. The physician can register every physiognomic phase accompanying the access, height, decrease, and passing away of mental disease. The humblest emigrant may carry with him miniatures, such as Dow could not have equalled in the perfection of their finish, of scenes and persons which will recall and revive the dearest affections of the home he has left."

The Report of the Kew Committee of the Association states that photography has been called into requisition for the purpose of recording observations. It says: "The photo-heliograph, erected in the dome of the Observatory, has been repeatedly at work since the beginning of last March, and excellent photographic pictures of the solar spots and faculæ were obtained. Certain alterations have been made by Mr. Welsh, in order to regulate the time of exposure of the collodion plate to the sun's action; with these alterations, the instrument gives very good results; but certain improvements in the arrangement of the secondary magnifying lens are under consideration, with a view of avoiding the depiction, on the collodion negative, of the inequalities of the glasses which compose it. The

committee recommend that arrangements should be made for the appointment of a competent assistant, who will undertake the taking of photographs, and the preparing of a certain number of copies for distribution to some of the principal British and foreign observatories." To follow out this recommendation of the committee, there will be necessarily an increase of expenditure, amounting to nearly 150*l.* per annum.

Micro-photographic Process.—Mr. Bryson, of Edinburgh, has devised a very convenient form of apparatus, consisting of a camera which, being in one piece, cannot be lengthened or shortened, as is the case with the common one. At the one end, or front of the camera, instead of the ordinary lens, is fixed a brass tube for supporting the object-glass of a microscope; and at the upper end, as well as at the centre and half-way between these two last points, may be inserted the ground focusing glass, or the frame which holds the sensitive plate. The stage, where the object to be taken is placed, slides upon a brass rod that projects from the front of the camera beneath the lens, thus constituting the coarse adjustment; while a fine focus is obtainedias follows:—The object-glass, by means of an adapter, is screwed to a brass tube, which slides within a larger one, attached, as already mentioned, to the front of the camera. By a fine screw and an opposing spring, the smaller tube may be more or less enclosed within the larger one, and consequently the object-glass brought nearer the stage, or removed further from it. The screw is connected by a metal rod, with a handle conveniently placed at the other end of the camera. Sometimes a microscope itself is attached to the camera, in which case the stage and focusing apparatus are not required. Those who are possessed of a microscope and one of the ordinary landscape or portrait cameras, may succeed in the process if they remove the lens from the camera and substitute for it the microscope deprived of its eye-piece; care, however, must be taken that a line passing longitudinally through the compound body of the microscrope shall fall at right angles upon the ground glass, and also that all extraneous light be excluded from the camera. The photographs may be taken by the ordinary collodion process. The time of exposure of the sensitive plate in the camera varies from a second up to even five minutes, if the day be dull. The light may be obtained by pointing the camera directly at the sun or a white cloud, or, more conveniently, indirectly from the sun by means of a mirror. The interposition of a piece of ground glass between the mirror and the camera diffuses the light over the field, and also renders it whiter and more agreeable.—*Proceedings of the Royal Botanical Society of Edinburgh.*

Fading of Photographs Prevented.—There has been read to the British Association, a letter from Mr. W. M'Craw, of Edinburgh, to Sir D. Brewster, "On a New Means of Preventing the Fading of Photographs." To accomplish this object, Mr. M'Craw has adopted the following formula:—

1. Take the white of eggs and add about 25 per cent. of a saturated solution of

common salt (to be well beaten up and allowed to subside). Float the paper on the albumen for thirty seconds, and hang up to dry.

2. Make a saturated solution of bichromate of potassa, to which has been added 25 per cent. of Beaufoy's acetic acid. Float the paper on this solution for an instant, and when dry it is fit for use. This must be done in the dark room.

3. Expose under a negative in a pressure frame in the ordinary manner, until the picture is sufficiently printed in all its details; but not over printed, as is usual with the old process. This requires not more than half the ordinary time.

4. Immerse the picture in a vessel of water in the darkened room. The undecomposed bichromate and albumen then readily leave the light and half-tints of the picture; change the water frequently, until it comes from the prints pure and clear.

5. Immerse the pictures now in a saturated solution of proto-sulphate of iron in cold water for five minutes, and again rinse well in water.

6. Immerse the pictures again in a saturated solution of gallic acid in cold water, and the colour will immediately begin to change to a fine purple black. Allow the pictures to remain in this until the deep shadows show no appearance of the yellow bichromate. Repeat the rinsing.

7. Immerse finally in the following mixture:—

Pyrogallic acid	2 grains.
Water	1 ounce.
Beaufoy's acetic acid	1 ounce.
Saturated solution of acetate of lead	2 drachms.

This mixture brightens up the pictures marvellously—restoring the lights that may have been partially lost in the previous part of the process—deepening the shadows, and bringing out the detail. Rinse finally in water, and the pictures are complete when dried and mounted. The advantages of this process are briefly as follows:—First, as to its economy; bichromate of potassa at 2*d.* per ounce, is substituted for nitrate of silver at 5*s.* per ounce. Secondly, photographs in this way can be produced with greater rapidity than by the old mode. Thirdly, the pictures being composed of the same materials which form the constituent parts of marking-ink, it may be fairly inferred that they will last as long as the paper on which they are printed.

Nevertheless, (says the able art-critic in the *Daily News*,) "there seems to have been no assured advance during the year towards securing the permanency of the actual photograph. Notwithstanding, also, the reports from time to time, no successful effort has been made to clear the bounds which nature, we believe, has immutably imposed in respect to colour; and the photographer has still to contend against her unapproachable extent of light and shade, and also the perplexing effects of the different degrees of photographic power in the variously-coloured rays."

New Dry Collodion Process.—Messrs. Murray and Heath have published the following statement:— "The Rev. J. Lawson Sisson, who resides at Lausanne, and whose excellent 'turpentine-waxed paper' negatives are well known to photographers, has communicated to us a new 'Dry' Collodion Process, which is certain and simple—even more so than the 'Fothergill' process. The plates which it is intended to prepare being properly cleaned, proceed thus. Have four dishes of the usual kind; in three of them put sufficient filtered rain water (distilled water would be better) to thoroughly cover a plate; in the fourth dish put about the same quantity of

raspberry syrup and water, in the proportions of ½ oz. of syrup to 3 oz. of distilled water. (The raspberry syrup, which there are chemical reasons for using, is that usually sold by confectioners.) Arrange the dishes side by side, the syrup dish being last. A plate is then coated and sensitized in the ordinary manner, and is put, film upwards, in the first water dish. A second plate is coated and sensitized, and when ready to be lifted from the nitrate bath, the first plate is removed to the second water dish, the second plate being put in the first water dish. A third plate is then prepared, and plates one and two moved on to the adjoining dishes; then a fourth plate is sensitized, and at this stage plate one is immersed in the syrup dish, and plates two and three in the second and third water dishes. After preparing a fifth plate, plate one is ready to be lifted from the syrup dish, and is then placed upright upon blotting-paper, to drain and dry. In this order the process is continued, the time required for coating and sensitizing a plate measuring exactly the time any other plate shall remain in one of the four dishes. The plates will keep as long, and, in use, are quite as sensitive as those prepared by any of the existing keeping processes; there are no blistering or albumen difficulties, nor is any special condition of collodion or bath requisite. Mr. Sisson uses the ordinary pyrogallic developer, merely, in the first place, putting for a few seconds a little water on the negative."

Photographic Engraving.—Mr. W. H. Fox Talbot has introduced this new process for Engraving by means of light. The principal features of the invention are—first, the etching of a photographic image formed upon a surface of gelatine and bichromate of potash without first distributing that surface by washing it with water or alcohol; secondly, the laying of an aquatint ground of resin or copal upon a surface of gelatine, and not, as usual, upon the naked metallic surface of the plate; thirdly, after forming a photographic image on gelatine, the heating of it strongly over a spirit-lamp, or otherwise; fourthly, the use of perchloride of iron as an etching liquid for the production of photographic engravings; fifthly, the use of the same substance as a substitute for aquafortis in common etching. A full description of the invention may be found in the *Photographic News** for October 22nd, or in the *Journal of the Society of Arts* for October 29th. The *Photographic News*, in pointing out the prospective advantages of this new art of photography, says:—" It appears to us that the importance of Mr. Talbot's invention—which it is impossible to over-estimate—chiefly consists in its applicability to the engraving of plates for the illustrations of books, at such a low rate, that even the cheap publications which, with one or two exceptions, are now obliged to content themselves with engraved woodblocks, may, instead of these, give an engraving which will be

* A journal commenced within the past year, and published weekly, for the *special* record of Photography and its multitudinous applications. The new *Journal is* very ably conducted, and well merits the large share of public *support which* it receives.

mathematically correct as regards perspective and the scale of the objects represented. For the illustration of books of natural history of animals, as well as of flowers and plants, this invention is invaluable; and even the most minute microscopical animalculæ (such as the parasite of the parasite of the bee described in a recent number) can be reproduced by photography in the camera, and then transferred to a plate by this process, with the correctness no human hand could give."

Photographic Engraving on Wood (Xylophotography). — This method for printing Photographs direct on to Wood is thus described in the *Photographic News*:—

We take a suitable block and cover it, in the darkened laboratory or by candle-light, with a mixture composed of oxalate of silver and water, to which may be added a little gum or pulverized Bath-brick, to suit the convenience of the engraver. The mode in which the oxalate is spread over the surface is precisely the same as that employed by wood-engravers in applying the mixture of flake-white and gum-water. A little of the substance—that is to say, about as much as would lie on a fourpenny-piece, for a block four inches square—is sprinkled on the surface, and, the finger being then dipped in water (either with or without the addition of a little gum), the mixture is spread evenly over the whole surface of the block by rubbing the finger backwards and forwards across the block in various directions, until the evaporation or absorption of the water leaves the surface impregnated with a delicate and almost impalpable coating of oxalate of silver. The block may be then placed in a drawer, or any other place from whence daylight is excluded, and there left till dry, or for any length of time until required, as we have detected no deterioration or loss of sensitiveness, even in blocks which had been prepared six months ago, so long as they remained protected from the light. Oxalate of silver is susceptible of being acted upon by the actinic rays; and when the block has been prepared in the manner above indicated, it is only necessary to expose it under a negative in the printing frame to sunlight, and a positive picture is obtained in the same manner as on paper prepared in the ordinary way. The block requires no subsequent washing, nor any preparation of any description, before being placed in the hands of the engraver; so that he receives it in precisely the same condition, as regards the surface to be operated upon, as under ordinary circumstances. The engraver, however, must not expose the block to the direct action of the solar rays while working at it, or it will gradually blacken on the surface; exposure to diffused daylight, however, has no deleterious effect on it, unless it be continued for a great length of time—say several hours. By this means, a photographer can, in a few minutes, take a photographic copy of a sketch, of the exact dimensions required, and this, in a very little time longer, can be transferred to the block, and the block be in the hands of the engraver. Besides the advantage of rapidity, the small cost at which the drawing can be transferred to a block would render it easy to have two or more blocks, so that when the first block showed signs of wear, a second could be substituted for it—a very important consideration when an immense circulation is taken into account.

Photographic and Stereoscopic Pictures.—Mr. J. Purnell, photographer, of Barnsbury, has proposed the following improvements in apparatus for taking Photographic Pictures:—A bath for the exciting fluid is let into the bottom of the camera, and over this bath a clamp is suspended by a rod through the top of the camera. The prepared plate having been placed in the clamp, is lowered by the rod into the bath, and the picture is taken while it is still held by the clamp. Afterwards the hand of the operator is introduced through a sleeve into the camera, and the plate is removed from the clamp and placed in a drawer at the bottom of the camera, which is then closed by a slide, and the drawer is removed for the deve-

loping operation to be effected. For this purpose a cover is used, which fits on the top of the drawer, and is furnished with eye-pieces glazed with yellow glass, to enable the operator to watch the operation. The bottom of the drawer is also of yellow glass. In the side of the cover is a pocket containing a bottle for the developing solution, which is now poured over the plate. When the developing of the picture is complete, water is poured over the plate through a trapped hole in the side of the cover, and allowed to run out by a valve at the bottom of the drawer. The picture is fixed in the ordinary manner. For taking stereoscopic pictures the inventor mounts the lens of the camera on a slide (as has heretofore been done for other purposes), and in taking the two pictures the lens is pushed first to one side and then to the other of the camera, so as to be opposite different parts of the plate; and to prevent the light falling on one side of the plate while the picture is being taken on the other side, he employs a partition.

"Niello" Paper.—Mr. Grant, of New York, to whom photographic art owes several contributions of more or less importance, has recently patented a process by which common paper may be prepared to serve all the purposes of the operator, with advantages superadded of no ordinary kind. The paper thus acted upon Mr. Grant terms "Niello;" when ready for the sensitizing operation it is perfectly black upon both sides and of a shining appearance, not unlike a piece of japanned leather. The principal ingredient used is a solvent of india rubber. The portraits exhibited upon this material have a peculiar softness and finish, much after the manner of the best miniatures of the end of the last century. The material being waterproof, and capable of bearing a great amount of rough treatment without injury to the picture thereon, gives it a great preference over the ordinary photographic paper for transmission through the post to distant parts, and an immunity from that fleeting and fading character which ordinarily results from the influences of the extremes of climate by reason of the varnish which secures the portrait after the more artistic appliance of colours has been effected. The colouring process of Mr. Grant is in itself peculiar, inasmuch as the pigment is applied in a dry and powdered state to the picture, and done with great rapidity—a rapidity, indeed, almost marvellous, when it is considered that the whole of the time consumed, from the beginning of the sitting to the delivery into the hands of the sitter of a really beautiful photographic miniature, is about three minutes.

Photograph of Bursting Shells.—Mr. Skaife, an artist of eminence, of Vanbrugh House, Blackheath, on June 1st, succeeded in taking a stereoscopic photograph during the practice-firing of shrapnell-shells at Plumstead Marshes, by the Royal Artillery, in which the shell itself is shown in the act of bursting. These results are unquestionably of a remarkable character, and appear to us to open the way to nautical and military experiments of the highest importance.

Mr. Skaife thus describes another successful result, on June 28, in a letter to the *Times*:—A 13-inch shell was fired from the mortar-battery by the 2nd company of the 1st battalion of Royal Artillery; the shell, weighing 200 lb., was ten seconds in traversing the air, and fell within two yards of the flagstaff, distant from the battery 600 yards. A photo-stereo was taken as the shell emerged above the smoke, showing three-eighths of an inch of the projectile's track, commencing at the distance of eighteen times the shell's diameter above the mortar, and 1¼-inch visual distance above the head of the superintending officer in front. But though this is, I believe, the first time a mortar shell has ever been photographed in its ascending flight sufficiently intense to print from, it is not that "What next?" to which I wish to call particular attention, but the likeness of the human head which so distinctly dominates in the smoke. This phantom does not appear to be the result of chance, for on repeating the experiment it is invariably reproduced at a certain phase of the smoke's expansion. Further, the apparition is not, nor can it, I believe, be seen by the human eye excepting through the medium of photography, which, in its highest instantaneity, appears to eternize time, by giving at the photographer's will a series of pictures of things which have their birth, marked phases of existence, and extinction in a moment (from the 20th to the 20,000th part of a second), much too fleeting to be noted by the naked human eye.

Subsequently, Mr. Skaife took a photo-stereograph of a 36-inch shell in the course of its flight, together with a phase of the mortar's explosion, which is confirmatory of what he intimates in the above letter, viz., that epochs of time inappreciable to our natural unaided organs of vision could be made evident to our senses by a photographic camera as decidedly as the presence of animalculæ in blood or water is by a microscope.

A gentleman well acquainted with the action of shot and shell, to whom the track of the projectile and its terminus in the stereo were pointed out, exclaimed, "But what stopped the ball?" To this Mr. Skaife replies:—A peculiarly rapid motion given to two small (each two inches square) thin pieces of baked india rubber, by means of a trigger movement, an optical illusion is produced on the transit of a projectile which may be likened to the stopping of a railway carriage by a brake.

The first application of this optical brake is perceived in the commencement of the shell's track on the side of the mortar. The shell then appears to have gradually decreased in speed, until it has gone the length of four of its diameters after the brake has been applied, when it appears finally to have stopped, and that for an interval sufficiently long to admit of its portrait being photographed accurately enough to give a tolerable idea of its size and shape. After which (it is assumed) the shell proceeded on its rapid course for one mile and a half further, arriving at its goal not one measurable iota of time less for its having lagged by the way to coquet with the photographer. And thus Mr. Skaife accounts for this seeming paradox:—The whole operation of putting on the optical brake to the flying projectile, stopping its course, and photographing its portrait, according to data supplied by this stereo, appears to have been done in the fiftieth part of a second. The shell at this part of its course is supposed to be flying at the rate of 500 feet per second (the diameter of the shell is believed to be about 2½ feet), when the now applied brake gradually retards its flight, and finally succeeds in stopping the shell after it has gone four diameters or ten feet from the first application of the brake. The commencement of the shell's track on the side of the mortar, it will be perceived, is misty and ill-defined; while, on the contrary, the termination is sharp, and gives a tolerably clear idea of the sort of snail that has been leaving its trail behind. This difference between the beginning and end of this photographed section of the projectile's parabola is thus accounted for:— The vulcanite "spring shutters" admitted to the sensitized collodionized plate, through a pair of lenses, a view of the shell the instant it emerged from the mortar's smoke, by being made to revolve on their axis 90 degrees, at which point they have exposed the full aperture of the lenses, and at this point the 100th part of a second has elapsed. Meanwhile the shell, flying at the rate of 500 feet per second, has just interposed its trail on the collodionized plate, the length of two of its diameters (⅛ inch), and succeeds in trailing two others while the shutters are having their action reversed and returned to their original light-excluding position, *behind the lenses*. Now, as the first part of the shell's track (1-16th of an inch wide) has been exposed to the full action of light from the commencement

of the shutters' opening to their final closing, this part of it has consequently been undergoing a gradual effacement during the whole period of the fiftieth part of a second; while, on the contrary, the terminus of the track photographed at the final closing of the shutters must in the shortness of its exposure to the action of light bear a *moving* analogy to the rapidity of light itself, known to travel more than one million of times quicker than a cannon ball. And hence the ball's apparent stoppage in the air *malgré* the tremendous physical force argument seen in the act of urging it forward.

But what (concludes Mr. Skaife) military man, however familiar he might be with the firing of projectiles, would believe, had he not witnessed the photographic fact, that that physical force argument, so sharply depicted in the stereo in question, was other than pure allegory, instead of being, as it actually is, the *bonâ fide* stereoscopic portrait of a real natural Cyclops, sprung into giant life by the igniting of 80 lb. of gunpowder in the most ponderous piece of artillery, probably, ever constructed by the hands of man?

PHOTOGRAPHY AND THE ELECTROTYPE IN PRINTING.

Mr. Henry Bradbury, in an Address delivered by him at the Royal Institution, on "Printing: its Dawn, Day, and Destiny,"* gives the following striking illustration of the combined results of Photography and the Electrotype.

Photography has many practical uses, but none of such value in expediting work and economizing expense, as in its application to the accurate reduction of Government surveys, for the purposes of the engraver; which by the old process required to be reduced by hand-work. It is, however, to the extraordinary power of the electrotype that we are indebted for its perfection; for by it, an intaglio printing-plate can be produced from a photograph, and copies multiplied, as in letter-press or copper-plate. Among the interesting applications, Mr. Bradbury gives the following:—

The art of Nature-Printing could not have been developed without the printing power of the electrotype.

The Ordnance Maps could never have been prepared with that facility and excellence for which they are so remarkable, without the intervention of the electrotype.

The highest art, and the most expensive labour of the historical engraver, can be reproduced from the steel plate, in all its perfection and all its fidelity, only by the agency of the electrotype.

Nay, more, photography itself, although a prime moving agent, owes its multiplying power, through the medium of a fixed plate, to the agency of the electrotype.

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* In this Address, the Author felicitously illustrates "the Power and Spread of Printing,"—its history and practice in all ages, with a graphic power and picturesqueness which impart new life to a subject whose origin is lost in the remotest ages of antiquity. The Address has been handsomely printed in quarto, and published by Messrs. Bradbury and Evans, Whitefriars.

Natural History.

ZOOLOGY.

RECENT PROGRESS OF ZOOLOGY.

Professor Owen, in his Address to the British Association, thus characterized the accessions to Zoology, since the Zootomical labours of Cuvier: Rapid and right has since been the progress of Zoology. Not only has the structure of the animal been investigated, even to the minute characteristics of each tissue, but the mode of formation of such constituents of organs, and of the organs themselves, has been pursued from the germ, bud, or egg, onward to maturity and decay. To the observation of outward characters is now added that of inward organization and developmental change, and Zootomy, Histology, and Embryology combine their results in forming an adequate and lasting basis for the higher axioms and generalizations of Zoology properly so called. Three principles, of the common ground of which we may ultimately obtain a clearer insight, are now recognised to have governed the construction of animals—unity of plan, vegetative repetition, and fitness for purpose. The independent series of researches by which students of the articulate animals have seen, in the organs performing the functions of jaws and limbs of varied powers, the same or homotypal elements of a series of like segments constituting the entire body, and by which students of the vertebrate animals have been led to the conclusion, that the maxillary, mandibular, hyoid, scapular, costal and pelvic arches, and their appendages, sometimes forming limbs of varied powers, are also modified elements of a series of essentially similar vertebral segments,—mutually corroborate their respective conclusions. It is not probable that a principle which is true for *Articulata* should be false for *Vertebrata;* the less probable, since the determination of homologous parts becomes the more possible and sure in the ratio of the perfection of the organization.

After pointing out the distinction between Affinity, which indicates an intimate resemblance, and Analogy, which indicates a remote one, he continued: The study of homologous parts in a single system of organs—the bones—has mainly led to the recognition of the plan or archetype of the highest primary group of animals, the Vertebrata. The next step of importance will be to determine the homologous parts of the nervous system, of the muscular system, of the respiratory and vascular system, and of the digestive, secretory, and generative organs in the same primary group or province. I think it of more importance to settle the homologies of the parts of a group of animals constructed on the same general plan, than to speculate on such relations of parts of animals constructed on demonstratively distinct plans of organization. What has been effected and *recommended, in* regard to homologous parts in the *Vertebrata, should be followed* out in the Articulata and Mollusca. In

regard to the constituents of the crust or outer skeleton and its appendages in the Articulata, homological relations have been studied and determined to a praiseworthy extent, throughout that province. The same study is making progress in the Mollusca; but the grounds for determining special homologies are less sure in this sub-kingdom. The present state of homology in regard to the Articulata has sufficed to demonstrate that the segment of the crust is not a hollow expanded homologue of the segment of the endo-skeleton of a vertebrate. There is as little homology between the parts and appendages of the segments of the Vertebrate and Articulate skeletons respectively. The parts called mandibles, maxillæ, arms, legs, wings, fins, in Insects and Crustaceans, are only "analogous" to the parts so called in Vertebrates. A most extensive field of reform is becoming open to the homologist in that which is essential to the exactitude of his science—a nomenclature equivalent to express his conviction of the different relations of similitude. Most difficult and recondite are the questions in face of which the march of Homology is now irresistibly conducting the philosophic observer. Such, for instance, as the following:—Are the nervous, muscular, digestive, circulating and generative systems of organs more than functionally similar in any two primary provinces of the animal kingdom? Are the homologies of entire systems to be judged of by their functional and structural connexions, rather than by the plan and course of their formation in the embryo? It may be doubted if embryology alone is decisive of the question whether homology can be predicated of the alimentary canal in animals of different primary groups or provinces. It is significant, however, of the lower value of embryological characters, to note that the great leading divisions of the animal kingdom, based by Cuvier on Comparative Anatomy, have merely been confirmed by Von Baer's later developmental researches. And so, likewise, with regard to some of the minor modifications of Cuvier's provinces, the true position of the Cirripeda was discerned by Strauss, Durkheim, and Macleay, by the light of anatomy, before the discovery of their metamorphoses by Thomson.

HOMOLOGY OF THE HUMAN SKELETON.

A PAPER has been read to the British Association, "On the Homology of the Skeleton," by Mr. G. M. Humphry, Surgeon to Addenbrooke's Hospital, Cambridge. Having lately been engaged in lecturing and writing upon the Human Skeleton, the author has carefully investigated the whole subject of its homology, in relation to the skeletons of the various vertebrate classes, and in relation to its development and connexion with the nervous system. The conclusions at which he arrives differ, in some particulars, from those of Professor Owen, more especially with regard to certain bones of the skull, such as the temporal bone, and the components of the anterior, or nasal, vertebra. His views, and the arrangement he proposes, are set forth in two Tables, in the second of which the bones are placed according to the plan of Professor Owen; the differences between the two being indicated by italics. He considers

that the pelvis consists of the hæmal elements of two sacral vertebræ; that the scapular arch consists of the hæmal elements of two cervical vertebræ; and that the limbs are appendages diverging from the points of junction of the hæmal spines with the hæmal alæ. The key to the comparison of the fore limbs with the hinder—a subject of much difficulty to anatomists—is furnished by the fact, that the limbs are placed at the anterior and posterior ends of the trunk; and that, consequently, the opposed surfaces of their upper segments, as well as of the pelvis and scapula, are made to correspond; that is, the anterior aspect of the hinder limb corresponds with the posterior aspect of the fore limb. This disposition of the parts takes place during development. At first, each limb is nearly straight; the hands and feet bud out from the sides of the trunk; the palms and soles look downwards; and the thumb and the great toe look forward. Subsequently, each limb undergoes a quarter turn, but in opposite directions. The anterior limb is rotated, on its axis, backwards; the posterior limb is rotated, on its axis, forwards; the ilium and femur slant, forwards, from the hip; and the scapula and humerus slant, backwards, from the shoulder; the knee bends forwards; and the elbow bends backwards. In the anterior limb, however, a rotation of the distal segments takes place, when the hand is pronated, in an opposite direction to that which has occurred in the proximal segments; and pronation is the easiest position to man, and is the ordinary position with most other animals.

Professor Owen, whilst congratulating the Section on the increased study of homology that this paper indicated, and the great ability displayed by the author, was prepared to defend, to a very large extent, his own previously expressed views. The only point he felt disposed at the present moment to concede, and at the same time allowing that the subject demanded, on his part, further attention before making any positive assertion, was the view Mr. Humphry had taken of the nature and position of the vomer. Mr. Humphry thought that Professor Owen's plan of regarding the Fish as the type of the vertebrate animals instead of Man was not the correct one, and his conclusions were arrived at by taking the human skeleton as the type.—*Athenæum*, No. 1615, where the Tables are printed.

ARTIFICIAL PRODUCTION OF BONE.

A PAPER upon this curious subject has been read to the French Academy of Sciences, and is thus reported in *Galignani's Messenger*:—The reparatory action of the periosteum (or membrane directly investing the bones) in reproducing the osseous substance when partially lost or destroyed, either by accident or disease, is a well-known fact, and various surgical operations are founded upon it; but Dr. Ollier's experiments, presented to the Academy as above, throw a new light on the subject. These experiments, performed upon rabbits, are divided into three series:—1. Long slips of periosteum were detached from the tibia throughout their length, one of their extremities only being left adherent to the bone. These slips were then rolled around the muscles of the leg in various ways, and in

the course of time bone was produced in various shapes, as, for example, a spiral, an 8, &c.! 2. In the second series of experiments the slips of periosteum were entirely detached from the bone three or four days after the operation, and, notwithstanding this separation from its primitive source of life, the periosteum still continued to produce bone. 3. In the third series the periosteum was entirely detached from the bone at the outset, and immediately transplanted to some other region, under the skin of the shoulder or of the back, for example; still the periosteum produced bone. An advanced age, it appears, diminishes this property of the periosteum, but does not completely destroy it. The osseous tissue thus obtained is real bone, similar to that of the rest of the body. After a certain time a cavity is formed within, containing marrow, which derives nourishment for three or four issues. In short, these curious experiments show that bone may be obtained wherever the periosteum can be introduced; and that a membrane may preserve its properties notwithstanding its removal and transplantation. The cure and treatment of fractures, it is expected, may be considerably improved by these unexpected facts.

NEW FACT CONCERNING BLOOD.

M. Claude Bernard has communicated certain observations to the French Academy of Sciences, tending to show that the custom of applying the denomination of red blood to that of the arteries, and of black to that of the veins, is not in accordance with facts. Having had occasion to open the renal veins of various animals, M. Bernard found them to contain red blood, strongly contrasting with the dark blood issuing from the vena cava below. In order to ascertain whether the same was the case with other veins belonging to organs of secretion, he opened the vein of the submaxillary gland of a dog, and found the blood of the darkest possible hue. At that moment, however, the salivary secretion had stopped. In order to excite it, a few drops of vinegar were introduced into the throat of the animal. The secretion recommenced, and after a few seconds the blood was seen to change its colour to the scarlet hue of arterial blood. As soon as the secretion ceased, the blood resumed its former dark colour. Hence M. Bernard concludes that although the name of red blood is correctly applied to that of the arteries, that of black blood cannot be with equal generality applied to that of veins; for that in the veins of the organs of secretion the colour varies according as the organ is in a state of action or repose.

LOCK-JAW.

The *Abeille Médicale* relates a case of traumatic tetanus cured by the inhalation of chloroform. The patient, a small landowner in the commune of St. Servant (Morbihan), had the index and the middle finger of his left hand crushed by the wheel of a cart heavily laden. The upper portion of the index had to be amputated, but the middle finger was saved. About three weeks after he caught cold, by running out at night in his shirt to give the alarm, a neighbouring house being on fire; two days afterwards the first symptoms

of Lock-jaw made their appearance, and continued to increase to an alarming degree. Dr. Paulus, of Josselin, being called in, first administered opiates and emollient enemas; then, observing that the wound of the index appeared unusually dry, dressed it with a pledget of lint steeped in chloroform. The rigidity of the body and muscular contractions increasing, he administered chloroform by inhalation, but not to a degree sufficient to obtain complete stupor. This at once afforded some relief to the patient, which lasted for the space of about an hour; the alarming symptoms then returned. The inhalations were repeated two or three times a day, anti-spasmodic potions being administered internally in the intervals. At length, at the end of the seventh day of this treatment, the spasms having assumed a remittent type, so as to return precisely at certain hours, the cure was completed with sulphate of quinine. A curious fact occurred in this case: the patient, who when in health laboured under a slight degree of deafness, could during his illness hear all that was said in the room, even in a low whisper; and this sensibility of the ear gradually disappeared as the cure progressed.

CARBONIC ACID EVOLVED FROM THE LUNGS.

Dr. E. Smith has read to the British Association a paper 'On the Results obtained from an Extended Inquiry into the Quantity of Carbonic Acid evolved from the Lungs under the Influence of various Agents." Dr. Smith had conducted a series of experiments extending over several months, and found that the quantity of carbonic acid expired varied most materially under the influence of different kinds of food, different states of the atmosphere, &c. During the summer, respiration is always feeble, as compared with the colder months of the year; and although the skin exercised most important functions, he found that it was not vicarious to the lungs in the expiration of carbonic acid; for while the lungs expired 600 grains, the skin threw off only six grains. The increase in the quantity of carbonic acid was greater and more enduring after eating oatmeal and rice, than after partaking of arrow-root; whilst wheat produced the greatest quantity, though the increase was less enduring than with oatmeal and rice. Tea, coffee, and cocoa were found to be respiratory exciters, and consequently increased the waste of the system; they could not be classed as food; but as tea induced perspiration, it was most valuable as a remedy against the action of heat. Tea caused the evolution of much more carbon than it supplied. Tea would also be useful in cases of drowning and interrupted pulsation. Brandy, sometimes administered in cases of drowning, had the very opposite effect to that desired, being a non-exciter of pulsation; whereas tea increased the action of the lungs and skin. If the object were to prevent the waste of the system, then alcohol might be useful, and tea would be improper; but if they wished to refresh themselves, tea should be taken. The experiments made showed that those who were more susceptible of injurious influence by heat, were the least able to bear any change of climate; and if this were borne in mind, it would be found of service to those who might contemplate going abroad—to the East or elsewhere.—*Athenæum* Report.

INFLUENCE OF EFFORTS OF INSPIRATION ON THE HEART.

DR. BROWN-SÉQUARD has communicated to the Royal Society, his "Experimental Researches on the Influence of Efforts of Inspiration on the Movements of the Heart."

A very interesting fact, of which many circumstances have been carefully investigated by Professor Donders and Dr. S. W. Mitchell, has received a wrong explanation from those physiologists. This fact consists in a diminution of either the strength or the frequency of the beatings of the heart, when an energetic effort at breathing is made and maintained for half a minute or a little more. Professor Donders thinks that this influence of inspiration on the heart is due to a mechanical agency of the dilated lungs on this organ. Dr. Brown-Séquard continues:

It is admitted that the state of the lungs has a great influence on the heart, but the principal cause of the diminution in the movements of this organ is very different from what has been supposed by Professor Donders, by Professor J. Müller, and others. It is known that when the medulla oblongata or the par vagum is excited (either by galvanism, as the Brothers Weber have discovered, or by other means, such as a mere compression, or a sudden wound, as I have found), the heart's beatings diminish or cease entirely. Whether this stoppage be due to the cause I have attributed it to or not, is indifferent to my present object. What is important is, that in these cases an irritation on the origin of the par vagum acts through it on the heart to diminish or to destroy its action. I thought that it would be interesting to decide, if, at the time that there is an effort at inspiration, there is not also an influence of the medulla oblongata on the par vagum, more or less similar to that which exists when we galvanize or otherwise irritate the medulla oblongata. To ascertain if it is so, I have made experiments on newly-born animals, and on birds. As I have already published some of the results of my researches on newly-born animals, and as these results are not so completely decisive as those of my experiments made on birds, I will merely give here a summary of what I have seen in these last animals. I have found the same facts in ducks, geese, and pigeons; but as I have repeated the experiments more frequently on the last-mentioned animals, I will speak of them only. When their abdomen has been widely opened and their heart exposed to sight, pigeons may live, as it is well known, for a long while. I wait until they are almost dying, having only one, two, or three inspirations in a minute, and then, if the weather is cold, and if the animal has lost many degrees of its temperature, I find that, at each effort it makes to inspire, the heart either almost suddenly stops, or beats much less quickly.

I have frequently seen the heart completely arrested for five or ten seconds, and twice for twenty or twenty-five seconds, in cases where there was only one respiration in two minutes. This stoppage of the heart's movements was the more remarkable, as they were at the rate of more than two hundred in a minute when the effort at inspiration took place. To decide that it was in consequence of an

influence of the par vagum that this occurred, I divided this nerve in the neck, and then found that there was no more influence of the inspiration on the heart, or if there was, it consisted in an augmentation of the frequency of the movements of this organ—an augmentation due to the shaking of the heart when the chest dilated.

Sometimes, when the heart was very irritable, and when the efforts at inspiration were still frequent and not energetic (the par vagum being undivided), these efforts were accompanied, or rather immediately followed, by an increase in the strength of the heart's movements, probably caused by the shaking. But always when the inspiratory efforts were energetic and rare, they co-existed with a diminution or a momentary cessation of the heart's contractions; and always in these cases the section of the par vagum has destroyed the diminishing influence of the respiratory efforts on the heart. It would be easy to show that the influence of the inspiratory effort on the central organ of circulation is comparable to the change taking place in the pupil when the globe of the eye is drawn inwards: it is an associated action.

From the facts I have found in the case of newly-born animals and birds, and from the facts observed in man by Professors J. Müller, Donders, and others, it results that, during efforts at inspiration, a nervous influence passes along the par vagum from the medulla oblongata to the heart, diminishing the movements of this organ. And, as by an action of our will we may inspire with energy, it follows that we can by an influence of our will diminish the action of our heart, just as we can contract our pupil by drawing our eyes inwards.

PHENOMENA OF GEMMATION.

Professor Huxley has read to the Royal Institution, a paper giving a detail of the circumstances which have more particularly drawn the attention of naturalists to the Aphides, or plant lice. Between the years 1740 and 1750, Bonnet, acting upon a suggestion of Reaumar, isolated an Aphis immediately after its birth, "and proved to demonstration that not only was it capable of spontaneously bringing forth numerous living young, but that these and their descendants to the ninth generation preserved a similar faculty." Ample testimony has since been borne by others to the accuracy of these observations; indeed, it has been shown, "that under favourable conditions of temperature and food, there is practically no limit to this power of asexual multiplication, or, as it has been conveniently termed, 'Agamogenesis.' The Aphides thus produced are either winged or wingless, and are both viviparous and oviparous. The only organic operation with which this mode of development can be compared is the process of budding or Gemmation, as it takes place in the vegetable kingdom, in the lower forms of animal life, and in the process of formation of the limbs and other organs of the higher animals; and the parallel is complete if such a plant as the bulbiferous lily or the *Marchantia*, or such an animal as the Hydra, is made the *term of comparison.*" These agamogenetic phenomena were long

supposed to be isolated; but numerous cases of a like, and some even more remarkable, character, are now known. Among these may be cited the circumstances attending the production of the drones of bees, as described by Von Siebold in his work on True Parthenogenesis; and attention was also directed to the Cœlobogyne Illicifolia, the male flowers of which have never been seen, and yet for the last twenty years it has produced its annual crop of fertile seeds in Kew Gardens. Agamogenesis has also been found to pass by insensible gradations into the commonest phenomena of life. Some explanation has been offered on this remarkable subject; all, however, that can be said is, we have a few facts, but cannot yet understand even the simplest of them.

ALTERNATE-GENERATION, PARTHENOGENESIS, &c.

IN continuation of the main subject of the extract at pp. 215-6, from Professor Owen's Address, he observed: "If embryology has been over-valued as a test of homology, the study of the development of animals has brought to light most singular and interesting facts, and I now allude more especially to those that have been summed up under the term 'Alternate-generation,' 'Parthenogenesis,' 'Metagenesis,' &c. John Hunter first enunciated the general proposition, that 'the propagation of plants depended on two principles—the one, that every part of a vegetable is 'a whole,' so that it is capable of being multiplied as far as it can be divided into distinct parts; the other, that certain of those parts become reproductive organs, and produce fertile seeds.' Hunter also remarked, that 'the first principle operated in many animals which propagate their species by buds or cuttings;' but that, whilst in animals, it prevailed only in 'the more imperfect orders,' it operated in vegetables 'of every degree of perfection.' The experiments of Trembley on the freshwater polype, those of Spallanzani on the Naids, and those of Bonnet on the Aphides, had brought to light the phenomena of propagation by fission, and by gemmation or buds, external and internal, in animals, to which Hunter refers. Subsequent research has shown the unexpected extent to which Hunter's first principle of propagation in organic being prevails in the animal division. But the earliest formal supercession of Harvey's axiom, '*omne vivum ab ovo*,' appears to be Hunter's proposition of the dual principle above quoted. The experiments of Redi, Malpighi, and others, had progressively contracted the field to which the '*generatio æquivoca*' could with any plausibility be applied. The stronghold of the remaining advocates of that old Egyptian doctrine was the fact of the development of parasitic animals in the flesh, brain, and glands of higher animals. But the hypothesis never obtained currency in this country; it was publicly opposed in my *Hunterian Lectures*, by the fact of the prodigious preparation of fertile eggs in many of the supposed spontaneously developed species; and in then suggesting that the *Trichina spiralis* of the human muscular tissue might be the embryo of a larger worm in course of migration, I urged that a particular investigation was needed for each particular species.

"Amongst the most brilliant of recent acquisitions to this part of physiology, have been the discoveries which have resulted from such special investigations. Kuchenmeister and Von Siebold have been the chief labourers." After noticing some of the results of those labours, Professor Owen said: "Since the time when it was first discovered that plants and animals could propagate in two ways, and that the individual developed from the bud might produce a seed or egg, from which also an individual might spring capable of again budding, —since this alternating mode of generation was observed, as by Chamisso and Sars, in cases where the budding individual differed much in form from the egg-laying one—the subject has been systematized, generalized, with an attempt to explain its principle, and greatly advanced, especially, and in a highly interesting manner, in Von Siebold's late treatise, entitled *Wahre Parthenogenesis bei Schmetterlingen und Bienen*, in which the virgin production of the male or drone-bee is demonstrated. Von Siebold having subjected to the closest microscopic scrutiny and experiment the conclusion to which the practical bee-master, Dzierson, had arrived, relative to the cause of queen-bees with crippled wings producing a swarm exclusively of drones, has demonstrated that the male bee is produced from an egg which has been subjected to no influence save that of the maternal parent; whilst such egg, if impregnated, would have produced a female or worker bee. The now well-investigated phenomena of parthenogenesis in Hydrozoa have resulted in showing, as in the analogous case of Entozoa, that animals differing so much in form as to have constituted two distinct orders or classes, are really but two terms of a cycle of metagenetic transformations—the acalephan Medusa being the sexual locomotive form of the agamic rooted budding polype, just as the cestoid tænia is of the cystic hydatid. In Hydrozoa (hydroid polypes or sertularians) the young are propagated, as in plants, by 'buds,' and also, as in most plants, by 'germs' or 'seeds:' these latter are contained in 'germ-sacs' projecting from the outer surface, which is another analogy to the flowering parts of plants. The first acquaintance with these marvels excited the hope that we were about to penetrate the mystery of the origin of different species of animals; but as far as observation has yet extended, the cycle of changes is definitely closed. And, since one essential step in the series is the fertilized seed or egg, the Harveian axiom, '*omne vivum ab ovo*,' if metagenetic phases be ascribed to one individual, may be still predicated of all organisms which bear the unmistakeable characters of plants or of animals.

"The closest observations of the subjects of these two kingdoms most favourable to insight into the nature of their beginning, accumulate evidence in proof of the essential first step being due to the protoplasmic matter of a germ-cell and sperm-cell; the former preexisting in the form of a nucleus or protoplast, the latter as a granulose fluid. In flowering plants it is conveyed by the pollen-tube, in animals and many flowerless plants, by locomotive spermatozoids. The changes of form which the representative of a species undergoes in successive agamically propagating individuals are termed the

'metagenesis' of such species. The changes of form which the representative of a species undergoes in a single individual, is called the 'metamorphosis.' But this term has practically been restricted to the instances in which the individual, during certain phases of the change, is free and active, as in the grub of the chaffer, or the tadpole of the frog, for example. In reference to some supposed essential differences in the metamorphoses of insects, it had been suggested that stages answering to those represented by the apodal and acephalous maggot of the Diptera, by the hexapod larva of the Carabi, and by the hexapod antenniferous larva of the Meloe were really passed through by the orthopterous insect, before it quitted the egg. Mr. Andrew Murray has recently made known some facts in confirmation of this view. He had received a wooden idol from Africa, behind the ears of which a Blatta had fixed its egg-cases, after which the whole figure had been rudely painted by the natives, and these egg-cases were covered by the paint. No insect could have emerged without breaking through the case and the paint; but both were uninjured. In the egg-cases were discovered, —1st, a grub-like larva in the egg; 2nd, a cocoon in the egg containing the unwinged, imperfectly-developed insect; 3rd, the unwinged, imperfectly-developed insect in the egg, free from the cocoon, and ready to emerge."

USE OF THE MICROSCOPE IN NATURAL HISTORY.

THE Microscope, as an adjunct to naturalists, has been of high service, which, however, has been overrated. Dr. Walker Arnott, in the *Proceedings* of the Royal Society of Edinburgh, observes:

Microscopical differences are by themselves of little importance. To see is one thing, to understand and combine what we see, another; the eye must be subservient to the mind. Every supposed new species requires to be separated from its allies, and then subjected to a series of careful observations and critical comparisons. To indicate *many apparently* new species is the work of an hour, to *establish* only *one* on a sure foundation is sometimes the labour of months or years. In microscopical natural history as much scrutiny is required to prove a new form to be distinct from its allies as in chemistry to discover a new alkaloid, or in astronomy to demonstrate the identity of two comets. A naturalist cannot be too cautious. It is better to allow diatoms to remain in the depths of the sea, or in their native pools, than, *from imperfect materials*, to elevate them to the rank of distinct species, and encumber our catalogue with a load of new names so ill-defined, if defined at all, that others are unable to recognise them; the same object can be more easily attained by attaching them, in the meantime, to some already recorded species, with the specific character of which they sufficiently accord. In all such cases the question to be solved for the advantage of naturalists is not whether the object noticed be a new species, but whether it has been proved such, and clearly characterized.

Mr. Warington has described to the British Association some

additions which he had made to his Portable Microscope, by which living objects contained in glass bottles or small aquaria could be examined with greater ease. Mr. C. Brooke exhibited a Microscope and Case very completely fitted up, but having a stand of so simple and light a character as to render it very portable and easily worked, even in the open air, at the sea-side, or elsewhere. Mr. Ladd introduced a Microscope with an improved Magnetic Stage. The improvements in the structure of the microscope exhibited by these instruments were commented on by several speakers. The facility of moving objects delicately by the hand afforded by the magnetic stage was remarked upon as a great advantage. Mr. Brooke's instrument was fitted with a double lens, so that the power could be changed from a high to a low one without unscrewing the glass, and was regarded as an improvement that ought to be more frequently employed in the construction of microscopes.

THE MICROSCOPE AND ATMOSPHERIC ORGANISM.

The Microscope (said Prof. Owen, in his Address to the British Association,) is an indispensable instrument in embryological and histological researches, as also in reference to that vast swarm of animalcules which are too minute for ordinary vision. I can here do little more than allude to the systematic direction now given to the application of the microscope to particular tissues and particular classes, chiefly due, in this country, to the counsels and example of the Microscopical Society of London. A very interesting application of the microscope has been made to the particles of matter suspended in the atmosphere; and a systematic continuation of such observations by means of glass slides prepared to catch and retain atmospheric atoms, promises to be productive of important results. We now know that the so-called red snow of Arctic and Alpine regions is a microscopic single-celled organism which vegetates on the surface of snow. Cloudy or misty extents of dust-like matter pervading the atmosphere, such as have attracted the attention of travellers in the vast coniferous forests of North America, and have been borne out to sea, have been found to consist of the "pollen" or fertilizing particles of plants, and have been called "pollen showers." M. Daneste, submitting to microscopic examination similar dust which fell from a cloud at Shanghai, found that it consisted of spores of a confervoid plant, probably the *Trichodesmium erythræum*, which vegetates in, and imparts its peculiar colour to, the Chinese Sea. Decks of ships, near the Cape de Verde Islands, have been covered by such so-called "showers" of impalpable dust, which, by the microscope of Ehrenberg, has been shown to consist of minute organisms, chiefly "Diatomaceæ." One sample collected on a ship's deck, 500 miles off the coast of Africa, exhibited numerous species of freshwater and marine diatoms, bearing a close resemblance to South American forms of those organisms. Ehrenberg has recorded numerous other instances in his paper printed in the *Berlin Transactions;* but here, as in other exemplary series of observations of the indefatigable microscopist, the conclusions are

perhaps not so satisfactory as the well-observed data. He speculates upon the self-developing power of organisms in the atmosphere, affirming that dust-showers are not to be traced to mineral material from the earth's surface, nor to revolving masses of dust material in space, nor to atmospheric currents simply; but to some general law connected with the atmosphere of our planet, according to which there is a "self-development" within it of living organisms, which organisms he suspects may have some relation to the periodical meteorolites or aërolites. The advocates of progressive development may see and hail in this the first step in the series of ascending transmutations. The unbiassed observer will be stimulated by the startling hypothesis of the celebrated Berlin Professor to more frequent and regular examinations of atmospheric organisms. Some late examinations of dust-showers clearly show them to have a source which Ehrenberg has denied. Some of my hearers may remember the graphic description by her Majesty's Envoy to Persia, the Hon. C. A. Murray, of the cloud of impalpable red dust which darkened the air of Bagdad, and filled the city with a panic. The specimen he collected was examined by my successor at the Royal College of Surgeons, Prof. Quekett; and that experienced microscopist could detect only inorganic particles, such as fine quartz sand, without any trace of Diatomaceæ or other organic matter. Dr. Lawson has obtained a similar result from the examination of the material of a shower of moist dust or mud which fell at Corfu, in March, 1857: it consisted for the most part of minute angular particles of a quartzose sand. Here, therefore, is a field of observation for the microscopist, which has doubtless most interesting results as the reward of persevering research.

THE LINNÆAN SOCIETY.

AMONG the numerous additions to the Library and Museum, received during the year, are a complete series of Wiegmann's Archiv fur Naturgeschichte, the greater part presented by George Busk, Esq., F.R.S. and L.S.; Linnæus's MS. Diary and Letters to Menander, with translation, presented by Miss Wray; an extensive collection of dried plants, formed in Java, by Dr. Horsfield, F.R.S. and L.S., presented by the Hon. East India Company; an extensive collection of Australian and Tasmanian plants, formed by Dr. Ferdinand Müller, Botanist to the North Australian Expedition, including type specimens of many species recently described by him in the Society's Journal, presented by Dr. Müller; and a valuable collection of British Algæ, formed by the late Mrs. Griffith, of Torquay, presented by the subscribers. The Society has also formed a British Herbarium; it has been now completely arranged, and the principles on which it had been formed have been explained.

PLANTS AND ANIMALS IN COMMERCE.

THERE has been presented to the Section of Zoology and Botany of the British Association, one of those Reports which render the labours of the Association so valuable in relation to science. At

the Glasgow Meeting in 1855 it was suggested by Prof. Balfour that it would be very desirable to obtain accurate information relative to the species of plants and animals which furnish the articles of commerce, and the extent to which the demand on each is carried. This was followed by the appointment of gentlemen at Liverpool and Glasgow to report on the animal and vegetable products imported into those cities. At the meeting in 1857, a very valuable Report was produced, by Mr. Archer, on the imports into Liverpool, and published in detail in the last volume of the *Transactions* of the Association. On this occasion a Report was brought up from Messrs. Connell and Keddie, on the animal, vegetable, and mineral substances imported from foreign countries into the Clyde. This paper was very voluminous, and of course could not be read in detail to the Section; but Dr. Lankester called attention to the importance of such returns, as, although the Government in the Board of Trade "Returns" gave the bulk of imports, yet little or no attempt was made at describing their sources or nature. In this way valuable products were imported, without the slightest intimation of their nature or value, under some general head, as "Drugs," or "Articles not otherwise enumerated," in the official returns. The publication of these Reports would draw especial attention to the source of each article, and thus enable those interested in their use or consumption to ascertain where they may be most easily obtained, and in the largest quantities. Several instances were quoted of valuable substances lying for years in our bonding warehouses from the want of a knowledge on the part of those engaged in their importation of their nature or value. These returns show the great national value of such Museums as those now established at Kew, South Kensington, Liverpool, Edinburgh, and Dublin, where the products of the animal, vegetable, and mineral kingdoms used in the arts and manufactures, and as food, are exhibited in connexion with the particular species of plant, animal, or mineral which yields them.—*Athenæum*, No. 1617.

A YOUNG HIPPOPOTAMUS

HAS been born in the Garden of Plants at Paris. The little creature made its appearance at the top of the water of the tank occupied by its mother about 6 A.M. on Monday, May 10. After swimming about a while, it attempted to get on dry ground, but the descent from the sleeping apartment of the parent hippopotami into their bath not being sloped, it had some difficulty in raising its weight out of the water. The mother then came to the rescue, but in her endeavours to assist her little one up the step, managed so to bruise and injure its tender body that it died the same evening. Accurate casts and drawings have been made of the animal. Such an event is not recorded to have ever taken place in Europe.

LEOPARDUS HERNANDESII.

A FELINE animal from Mazatlan has been described under the above name, which becomes very interesting from the fact of large

animals of this family being comparatively few in the New World. "This species greatly resembles the jaguar in size, character, and marking, having the short legs and short tapering tail of that species; but it chiefly differs from that animal in the form of the head, which is more elongate, and in the disposition of the spots: instead of these being all placed in rings or roses, as they are usually called, the spots on the front part of the body are single and scattered, and those on the hinder part of the body are alone placed in rings and roses."—*Dr. J. E. Gray.*

RARE BAT.

MR. GOULD has exhibited to the Zoological Society a drawing of a very remarkable Bat which has lately been transmitted to him from Melbourne, Victoria, by Dr. Ludwig Becker, under the impression that it was a new and undescribed species, but which proves to be identical with the *Molossus Australis* of Dr. Gray, characterized more than twenty years ago from the unique example contained in the Museum of the United Service Institution. Mr. Gould remarked that the receipt of this drawing is of especial interest, inasmuch as it proves that the animal is a native of Australia, a fact which, from the circumstance of no other example than the one referred to having been hitherto found in that country, has been disputed; the form being Brazilian.

THE DINGO.

SOME discoveries lately made by Mr. Selwyn, the Government geologist, in exploring a cave near Mount Macedon, throw much light on the disputed question of the introduction of the Wild Dog to Australia. Professor M'Coy has stated that there is little doubt that the animal is indigenous; and a paragraph in a Melbourne publication, edited by Mr. W. H. Archer, the Assistant Registrar-General, relates, on the authority of Mr. Smyth, that the skeleton of a Dingo was discovered near Warnamborl, underneath a bed of volcanic ash. The skeleton was found by C. Campbell, Esq., an engineer who was conducting some excavations in that neighbourhood. The discovery of such a skeleton is of interest, establishing, as it does, the truth of Professor M'Coy's conjecture, which was founded on palæontological data.—*Athenæum,* No. 1616.

WILD BOARS IN FRANCE.

A HERD of Wild Boars was seen in December, 1848, near Rheims, in the forest of Gueux. It was estimated there were twenty old and young, and these latter were at first taken for wolves by some persons, who attacked them, and killed four young ones. The main body of the animals then dispersed towards Dieu-Lumière, and the keeper of a wineshop shot two, the weight of which was from 100 to 115 kilogrammes each. A stray animal having entered a timber-yard near Rheims, was surrounded by the workmen, fourteen in number, and one of them, after having dealt it a blow with a hatchet, was bitten by it in the hand. The animal was then de-

spatched by the other men; it weighed 150 kilogrammes Being cut up into fourteen parts, it was distributed among the assailants, and the wounded man received the skin in addition. On the whole, about fourteen boars are believed to have been destroyed in this singular hunt, most of them young ones.

BOSCH-VARK OF THE CAPE.

THE Secretary has read to the Zoological Society, a paper, by Dr. Gray, "On the Bosch-Vark (*Patamochœrus Africanus*), living in the Society's Gardens." Some doubt having been expressed as to the distinctness of the Painted Pig of the Cameroons from the Bosch-Vark of the Cape, it was with great pleasure Dr. Gray was enabled to examine a living specimen of the latter, and he is quite convinced that any one who examines the two living animals as they are placed side by side in the Gardens, cannot fail to be satisfied with the distinctness of the species, independent of any variation that may occur in the ground colour of the individual.

ON THE TORPIDITY OF THE MARMOT.

THE object of this memoir by M. Valentin is to examine the influence of the winter-sleep upon the production of glucose by the liver. During an abstinence from food of five or six months, the sugar is persistent in the liver of the Marmot; from this it follows that there is an essential difference between the true winter-sleep of the marmot and the torpidity of the batrachia, or the state of inanition of waking animals.

When, as is sometimes the case, the death of the animal is caused by exhaustion at the end of the winter-sleep, the liver no longer contains sugar. The same fact is observed in hedgehogs which have died during their winter-sleep. On the contrary, when a healthy marmot, killed at the end of its torpidity, is examined, it is found that the fresh blood of the aorta and the fresh urine will precipitate small quantities of protoxide of copper, showing that they contain glucose.

Some authors have expressed the opinion that the liquid secreted by the stomach is absorbed, and that after passing through the vena porta, it produces sugar in the liver. M. Valentin opposes this view, and cites several facts which speak against it.

The author has observed a striking difference between the sugar of the liver of Marmots in their winter-sleep and that of other waking animals; the former is not so readily destroyed by putrefaction as the latter.

In conclusion, he cites an observation made upon some frogs which had passed four months of the winter in a dark cellar. They were frozen by exposure to a temperature of + 5° F.; the sugar of their liver did not disappear.—*Moleschott's Untersuchungen.*—*Philos. Mag.*, No. 102.

NEW RAT.

DR. SALTER has exhibited to the Linnæan Society a living speci-

men of a species of Rat, probably new to science, but which has been frequently observed of late on board vessels in British ports; and made some observations on the characters by which it is distinguished from the original British Rat (*Mus Rattus*), the principal of these being the extraordinary length of the tail, the large size of the ears, and the greater fleshiness of the thighs.

ARTIFICIAL INCUBATION.

A NEW apparatus for this purpose has been presented to the French Academy of Sciences by M. Séguier. The usual method of hatching eggs artificially consists in placing them between layers of manure; M. Séguier, on the contrary, places them in nests consisting of straw, hay, shavings, &c., just as they would be in the case of natural incubation. Moreover, in the latter the egg receives warmth from above; and the same effect is imitated in the new system, which consists of a central stove from which eight or ten pair of india rubber tubes issue in various directions. Each pair establishes a communication between the stove and an india rubber cap, which covers a nest filled with eggs. The steam generated in the stove is thus made to circulate constantly over the eggs, which are thus exposed to a moderate heat radiating upon them from the concave surface of the india rubber cap. The warming apparatus described to the Academy communicates warmth to eight nests, each containing twenty-four eggs; but the number of nests might be much greater.

ARRANGEMENT OF BIRDS.

MR. EYTON has read to the British Association, a paper in which he stated:—The mode in which birds obtain their prey is subject to considerable variation: adapted to this variation are the various members and organs of the class. The principal modes in which birds obtain their prey are the following:—by the power of flight or direct chase; by the power of approaching their prey unobserved; by the power of climbing; by the power of scratching and running; by the power of wading; and by the power of swimming. If a division of birds is made strictly according to the above qualities, there will be many that will not conform strictly to the greatest perfection of development adapted to each mode of living, but are endowed with a modification or mixture of two or more of them. Mr. Eyton proposes to divide birds into the following orders:—1. Raptores, or birds of prey, containing the families Vulturidæ, Falconidæ, and Strigidæ; 2. Noctivores, or night-feeding birds, containing the Caprimulgidæ, Trogonidæ, and Coracinidæ; 3. Volatores, or flyers, containing the Trochilidæ and Cyprilidæ; 4. Lapsatores, or gliders, containing the Alcidinidæ, Buceridæ, and Upupidæ. Mr. Eyton called the attention of the meeting to the peculiar mode in which the coracoid bone is articulated to the sternum among the humming-birds, and exhibited a drawing and specimens of those parts. He also stated that he was bringing out a work on the skeletons of

birds, some of the plates from which he expected to have been able to exhibit.

Sir W. Jardine remarked on the difficulty of arranging birds, and admitted that Mr. Eyton's arrangement had the advantage of presenting birds in groups according to their habits, which depended so largely on the nature of their food.

OSTRICHES IN FRANCE.

The Bulletin of the Société d'Acclimatation publishes a note from Dr. Vavasseur on the subject of the Nandou, or South American Ostrich, and on the means of bringing it into a domestic state, and accustoming it to the climate of France. The South American ostrich, although of the same natural family as those in Africa and elsewhere, differs from them by being of rather smaller stature, and by having three toes on the feet instead of two. They live in numerous bands in the part of South America comprised, from north to south, between the frontiers of the Brazils and Patagonia, near the Straits of Magellan, and from east to west between the Atlantic and the Cordilleras of the Andes. They only frequent the open plains, and never enter into the wooded parts of the country. They are commonly found in the plains of the Republic of Uruguay, but are very rare in Paraguay. They generally move about in bands of ten and sometimes twenty females, with a single male, which walks generally at their head, and is besides readily distinguishable by his larger size. They may be seen seeking their food in the midst of horses and cattle, with which they are always on the best terms. In Uruguay and in Buenos Ayres, where these birds are seldom hunted, they show no alarm at man, but come and feed close to houses; but if they see one or two horsemen approach, as if to surprise them, they run off with extreme swiftness.

The American ostrich is a very quiet and even stupid bird, and its name, "aveztruz," is liberally applied, particularly by the women, to any one who does not evince much intelligence. Although of a generally pacific character, the male ostriches sometimes have battles to defend their own females or to capture some from other hands, and they then give each other most furious kicks, but their movements on these occasions are ridiculously awkward. The force, however, of their kick is enough to break a man's leg, and such accidents have sometimes occurred. Their laying season is in the month of August; their nest consists of a large hole in the ground, which they do not make themselves, but use those which the bulls make with their fore feet in order to cover themselves with a cload of dust, which is a favourite custom of those animals. The number of eggs generally found in these large nests is from twenty-five to thirty, but it is not uncommon to find from sixty to eighty. It is thought that all the females belonging to one band lay in the same nest. It is not true, as has been stated, that these eggs are hatched by the heat of the sun, for both the males and the females have been seen sitting on them, but more frequently the former. The flesh of the young ones is good, though rather strong; but that of the grown birds is disagree-

able. The eggs, however, form a very good article of food, and are sought after by the country people for that purpose. The food of the ostriches consists of insects, seeds, and sometimes of small reptiles, such as small lizards, &c.; but they are in general so voracious that they will swallow anything; and pieces of leather, iron, &c., have been found in their stomachs. The young ostriches may be readily tamed, for they become familiar in two or three days. They must not be placed in a cage, but allowed to walk about, attaching something to their feet to prevent their going too far. They are fed with little bits of fresh meat, which they will take from the hand. They will walk about round the houses, enter into all the rooms, look with apparent curiosity at what is going on, and occupy themselves with catching flies, of which they are very fond. As they grow larger they go further from home, but they never fail to return at the time when they are usually fed, or at night to roost. They are very fond of sugar, and will follow a person about to procure it. Dr. Vavasseur concludes by stating that the South American ostrich would live without difficulty in the north of France; that there is no difficulty in domesticating it; that it will feed on anything that is given to it, however coarse; that it is of a very strong constitution, and but little sensible to atmospheric changes; and that it scarcely requires any care, space and liberty being all that is wanted. The advantages which might be derived from domesticating this bird would consist in its feathers, which are in great demand; and from the eggs, which would form a good article of food to the people in the country.—*Galignani's Messenger.*

NEW BIRDS.

MR. GOULD has read to the Zoological Society, a paper "On a New Species of Ptarmigan," the skin of which he exhibited. It was a native of Spitzbergen, where he believed it was plentiful, and was brought to this country by E. Evans, Esq., of Neath, who shot it during a visit to that part of the world in the summer of 1856. In size it considerably exceeded our common ptarmigan. Mr. Gould proposed the name of *Lagopus hemileucurus* for this species. Mr. Gould also read a paper, containing Descriptions of two new species of the family Hirundinidæ: one, an Atticora from Guatemala, for the introduction of which science was indebted to G. U. Skinner, Esq., he characterized under the name of *A. pileata;* the other, a Chelidon, from Cashmere, which he proposed to call *C. Cashmeriensis,* was discovered by Dr. A. L. Adams, of the 22nd Regiment.

BIRDS FROM ECUADOR.

THERE have been read to the Zoological Society, some notes "On a Collection of Birds received by M. Verreaux, of Paris, from the Rio Napo, in the Republic of Ecuador," when it was stated that although several small collections of birds had been already received in Europe from this locality (one of which had been brought before the notice of the Society), the present was larger and of a

more interesting nature, embracing no less than 170 species, at least 20 of which appeared to be undescribed. The most noticeable objects were two Tanagers, which seemed not only generically but specifically different from anything hitherto known, and which were characterized as *Creurgops verticalis* and *Euchætes cœcineus*, a fine series of Formicariidæ, embracing thirty-three species, of which several appeared to be undescribed; and a new form belonging to the peculiar South American family Pteroptochidæ, for which the name *Agathopous micropterus* was proposed. The Chairman stated that M. Jules Verreaux had previously examined and labelled the birds of this collection, and that the greater part of the new appellations were adopted from his MS.

The Chairman also called the attention of the Society to a very scarce parrot lately acquired for the menagerie, and of which only one other specimen was known, formerly living in the Zoological Gardens at Amsterdam, and now in their museum. This was the *Eclectus cornelia* of Prince Bonaparte.

NEST OF THE WAXWING.

The Waxwing makes a good-sized and substantial Nest, but without much indication of advanced art. It is of some depth, and regularly shaped. The main substance of which it is built is the kind of lichen commonly called "tree-hair" (*Alectoria jubata*), which hangs so abundantly from almost every tree in Lapland. The nest is strengthened below by a platform of dead twigs, and higher up towards the interior by a greater or lesser amount of flowering stalks of grass, and occasionally pieces of equisetum. In one nest there were several pen-feathers of small birds as an apology for a lining. The nest is built on the branch of a tree, not near the bole, and rather standing up from the branch, like a fieldfare's or other thrush's nest. Of those observed, four were built on small spruces, one on a good-sized Scotch fir, and one on a birch, all at a height of from six to twelve feet from the ground.—*John Wolley, Jun.*—*Edin. New Phil. Journ.*, No. 15.

NEW TOUCAN.

Mr. Gould has exhibited and described to the Zoological Society, a new species of Toucan, which he had recently received from Professor Jameson, of Quito. He remarked that it belonged to that division of the group to which he had applied the generic term of *Andigena*, and that it was most intimately allied to the *A. nigrirostris*, but differed from that species in the bill being shorter, broader, and much more robust, and coloured with obscure brownish red at the base of the upper mandible. For this new species he proposed the name of *Andigena spilorhyncha*.

BIRDS FROM THE AROO ISLANDS.—BIRDS OF PARADISE.

Mr. Gould has brought under the notice of the Zoological Society, a highly interesting series of Birds collected by Mr. A. R. Wallace in the Aroo Islands. Among them are two species of

Birds of Paradise—*Paradisea apoda* and *P. regia*. Hitherto these magnificent birds have only been sent to this country in a mutilated condition, their skins having been prepared and dried by the Papuans frequently without their wings, and almost always without their legs; Mr. Wallace's skins, however, are perfect, and in the highest possible condition. They comprise not only adult males and females, but young birds in various stages of development. Mr. Gould remarked that the ornithology of the Aroo Islands, like that of New Guinea, partook more of the character of the Australian fauna than of any other. The *Picidæ* (Woodpeckers) and *Bucerotidæ* (Hornbills), so common in India and the Indian Islands, are totally wanting, while the *Meliphagidæ* (Honeyeaters) and the *Halcyonidæ* (Kingfishers) are very numerous; on the other hand, the collection does not contain a single *Malurus*, nor any of the *Finches*—forms represented by numerous species even in the northern parts of Australia. Mr. Gould, in remarking upon the beautiful plumes which adorn the *Paradiseæ*, stated that he considered they were in their most perfect state just prior to the breeding season, and that the bird was then adorned in its greatest beauty,—a beauty assumed apparently not only for the purpose of attracting the females, but to exhibit to each other their gorgeous finery, when they assemble and perform many curious and extraordinary evolutions. In South America, the Cock of the Rock (*Rupicola*) has many singular habits at the like season; while in Australia, the Bower Birds attract every one by the curious structures they make for a similar purpose. Mr. Gould instanced also the Peacock, the Turkey, and the well-known Ruff of the British Islands, as birds which assemble and make such displays.

NEW BIRDS FROM WESTERN AFRICA.

Dr. Gustav Hartlaub, of Bremen, having recently examined the magnificent specimens in the British Museum, found among them some very rare species, which he had not seen before. Among these are some of the rare types collected during the second Niger Expedition by Mr. Louis Fraser—for instance, the *Sylvicola superciliosa* of that naturalist, which from a second and more perfect Ashantee specimen Dr. Hartlaub found to be what he never expected, a typical *Camaroptera;* then the *Coccothraustes olivaceus* of Fraser, a type most peculiar and unique amongst the great number of African Fringillidæ. But by far the most interesting and most curious African form, which Dr. H. has seen for the first time, is a little bird hardly larger *than the smallest Humming-bird*, the *Dicæum Rushiæ* of Cassin, and the type of the genus *Pholidornis*. This minute and very peculiarly coloured species is the only true African representative of the essentially Asiatic form *Dicæum*, from which, however, Dr. Hartlaub holds it to be truly generically distinct.

THE MOORUK, AND ITS EGG.

This interesting addition to the gardens of the Zoological Society *is a bird of the* same order as the ostrich, rhea, emeu, and cassowary.

The wings are abortive—that is, so short as to be useless for flight, though very necessary, abbreviated as they are, for many purposes in the economy of the bird. The above specimen was taken in New Caledonia, and brought to Dr. Bennett, of Sydney, who observed its habits in a paddock to closely agree with those of the cassowary. One of its calls is "Mouruk," and hence the native name. It is smaller than the cassowary, and wants the horny casque or helmet on the head, which made that bird so strange to our forefathers: this, with the greatly reduced turkey-neck wattles, gives it the look of a young bird. It may be, after all, only a young cassowary, and time may develop his bony crest. The great interest of the bird to the student is the development of our knowledge of geographical distribution. Mr. Gould has named it *Casuarius Bennetti;* and, if it be a distinct species, it shows that small islands have had large species assigned to them with a limited range. Thus, Sir Thomas Stamford Raffles, in a letter to Mr. Marsden, quoted in a *Popular History of Birds,* writes that the cassowary is confinèd to two small islands in the Eastern seas; just as the emeu is limited to Australia and Tasmania, the rhea to South America in its south portions, and the ostrich to Africa; the dodo and dronte, the vast æpyornis, and the gigantic moa, or dinornis, of New Zealand, are all birds that were placed by their Maker in limited islands; and the present bird may be *the last of the mooruks,* just as there was a last dodo, and there may be a last giraffe.

Dr. Gray has read to the Zoological Society a note upon the Egg of this Mooruk. The Egg is of the same form and has the same solid shell, covered with rounded tubercles, as that of the Common Cassowary, *Casuarius galeatus.* It differs from the egg of the latter bird in the British Museum in being rather larger (it is 14¼ inches in circumference in the longest, and 11½ inches in the thickest part), in the tubercles on the surface being larger, considerably further apart, and more isolated—that is to say, more rarely confluent together. The egg is pale olive-green with darker olive tubercles; it is much darker than what Dr. Gray recollects of the eggs of the Cassowaries in other collections; but they may have become faded, as is the case with our specimens in the British Museum.

Dr. Bennett sent with the living specimen of the Mooruk now exhibited in the menagerie, an egg which was brought from New Britain with the bird; it differs very considerably from one exhibited by Mr. Stevens: first, in being smaller—that is to say, only 13½ inches in circumference in the longest and 11 inches in the thickest part; secondly, in the egg being blunter, more rounded in front, and not so conical as the other; thirdly, it is of a uniform pale olive-colour, without any appearance of tubercles or darker spots.

It has been suggested that the difference between the two eggs is so great that they cannot have been laid by the same species of bird. They both differ considerably from the egg of the Galeated Cassowary; and Mrs. Turner assured Dr. Gray that they were both brought *from New Britain,* by her husband and the captain of the *ship, with the living* bird, to Sydney; they were divided by lot, and

he, having the choice, selected the tuberculated egg: so that, if they are not the eggs of the Mooruk, it would indicate that there must be two Cassowaries inhabiting New Britain, both different from *C. galeatus.*

There is so great a similarity in colour and texture of the smooth egg with the ground-colour of the other egg between the tubercles, as to have suggested that the tuberculated egg is the perfect egg of the bird, and the smooth egg that of a very immature or sickly specimen; but under any circumstances Dr. Gray considered it desirable that both specimens should be figured.

A TALKING CANARY.

MR. LEIGH SOTHEBY, in a letter to Dr. Gray, describes a marvellous little specimen of the feathered tribe, a Talking Canary. Its parents had previously and successfully reared many young ones; but three years ago, they hatched only *one* out of four eggs, the which they immediately neglected, by commencing the rebuilding of a nest upon the top of it. Upon this discovery, the unfledged and forsaken bird, all but dead, was taken away and placed in flannel by the fire, when after much attention it was restored and then brought up by hand. Thus treated, and away from all other birds, it became familiarized with those only who fed it; consequently, its first singing notes were of a character totally different to those usual with the Canary.

Constantly being talked to, the bird, when about three months old, astonished its mistress by repeating the endearing terms used in talking to it, such as "*Kissie, Kissie,*" with its significant sounds. This went on, and from time to time the little bird repeated other words; and now, for hours together, except during the moulting season, it astonishes by *ringing the changes,* according to its own fancy, and as plain as any human voice can articulate them, on the several words—"*Dear sweet Titchie*" (its name), "*Kiss Minnie,*" "*Kiss me then dear Minnie,*" "*Sweet pretty little Titchie,*" "*Kissie, kissie, kissie,*" "*Dear Titchie,*" "*Titchie wee, gee, gee, gee, Titchie, Titchie.*"

The usual singing notes of the bird are more of the character of the Nightingale, mingled occasionally with the sound of the dog-whistle used about the house. It whistles also, very clearly, the first bar of "*God save the Queen.*" It is hardly necessary to add that the bird is by nature remarkably tame.

Mr. Waterhouse Hawkins, who has heard the bird, relates that about twenty years ago a Canary that spoke a few words was exhibited in Regent-street, the only other instance, it is believed, publicly known.—*Proceedings of the Zoological Society.*

ON THE SNIPES' "NEIGHING" OR HUMMING NOISE, ETC.

THE following paper by M. Meves, Conservator at the Zoological *Riks-Museum* in Stockholm, translated and communicated by Mr. *John Wolley,* jun., has been read to the Zoological Society.

On the origin of the neighing sound which accompanies the single Snipe's (*Scolopax gallinago*, L.) play—flight during pairing time—opinions are various. Bechstein thought that it was produced by means of the beak; Naumann and others, again, that it originated in powerful strokes of the wing; but since Pralle in Hanover observed that the bird makes heard its well-known song or cry, which he expresses with the words "gick jack, gick jack!" at the same time with the neighing sound, it seemed to be settled that the latter is not produced through the throat. In the meantime (says M. Meves), I have remarked with surprise, that the humming sound could never be observed whilst the bird was flying upwards, at which time the tail is closed; but only when it was casting itself downwards in a slanting direction, with the tail strongly spread out.

The peculiar form of the tail-feathers in some foreign species nearly allied to our Snipe (for example, *S. Javensis*) encouraged the notion, that the tail, if not alone, at all events in a considerable degree, conduced to the production of the sound. On a closer examination of the tail-feathers of our common species, I found the first (outer) feather, especially, very peculiarly constructed; the shaft, uncommonly stiff, sabre-shaped; the rays of the web strongly bound together and very long, the longest reaching nearly three-fourths of the whole length of the web, these rays lying along (or spanning from end to end of the curve of) the shaft, like the strings of a musical instrument. If you blow from the outer side upon the broad web it comes into vibration, and a sound is heard, which, though fainter, resembles very closely the well-known neighing.

But to convince yourself fully that it is the first feather which produces the peculiar sound, it is only necessary carefully to pluck out such a one, to fasten its shaft with fine thread to a piece of steel wire a tenth of an inch in diameter and a oot long, and then to fix this at the end of a four-foot stick. If now you draw the feather, with its outer side forward, sharply through the air, at the same time making some short movements or shakings of the arm so as to represent the shivering motion of the wings during flight, you produce the neighing sound with the most astonishing exactness.

If you wish to hear the humming of both feathers at once, as must be the case from the flying bird, this also can be managed by a simple contrivance. Take a small stick, and fasten at the side of the smaller end a piece of burnt steel wire in the form of a fork; bind to each point a side tail-feather; bend the wire so that the feathers receive the same direction which they do in the spreading of the tail as the bird sinks itself in flight; and then with this apparatus draw the feathers through the air, as before.

Such a sound, but in another tone, is produced when we experiment with the tail-feathers of other kinds of Snipe. But in *S. major*, *Capensis*, and *frenata* are found four humming-feathers (*surr pennor*) on each side, which are considerably shorter than in the species we have been speaking of. *Scolopax Javensis* has eight on each side, which are extremely narrow and very stiff.

Since in both sexes these feathers have the same form, it is clear that both can produce the humming noise; and by means of experiment I have convinced myself that it is so. But as the feathers of the hen are generally less than those of the cock bird, the noise also made by them is not so deep as in the other case. Professor Nilsson announces, that in the female of the Single Snipe a neighing noise has been already observed.

It would be interesting if travelling ornithologists would in future make observations on the foreign species in a state of nature. It ought to be found that these also have a neighing or humming noise, but differing considerably from that of our species.

Besides the significance which these tail-feathers have as a kind of musical instrument, their form may give a very weighty character in the determination of species standing very near one another, which have been looked upon as varieties.

The structure of the tail-feathers in *Scolopax* (Philolimnos, Brehm) gallinula, L. *differs considerably* from that of the others; it gives upon experiment no humming

sound; and all the feathers of the tail are, as in *Scolopax rusticola*, formed pretty much like one another.

If it be considered desirable to divide the Linnæan genus *Scolopax* into subgenera, I should propose to class those together which have musical feathers in the tail, under the name *Odura*.

The interesting discovery recorded in the above paper was first announced by M. Meves in an account of the birds observed by himself during a visit to the island of Gottland in the summer of the year 1856, which account appeared in a publication of the Vetenskaps Akademi at Stockholm the following winter.

In the succeeding summer M. Meves showed Mr. Wolley his experiments. The mysterious noise of the wilderness was reproduced in a little room in the middle of Stockholm. First the deep bleat now shown to proceed from the male Snipe, and then the fainter bleat of the female, both most strikingly true to nature, neither producible with any other feathers than the outer ones of the tail.

Mr. Wolley inquired of M. Meves how, issuing forth from the town for a summer ramble, he came to discover what all the field-naturalists and sportsmen of England and other countries had, for the last century at least, been in vain trying to make out, straining their eyes, and puzzling their wits? He freely explained how, in a number of *Naumannia*, an accidental misprint of the word representing tail-feathers instead of wing-feathers—a mistake which another author had ridiculed — first led him to think on the subject. He subsequently examined in the Museum the tail-feathers of various species of Snipe, remarked their structure, and reasoned upon it. Then he blew upon them, and fixed them on levers that he might wave them with greater force through the air; and at the same time he made more careful observations than he had before done on the living birds in the breeding season. In short, in him the obscure hint was thrown upon fruitful ground, whilst in a hundred other minds it had failed to come to life. M. Meves then wrote, at Mr. Wolley's request, for the Zoological Society of London the paper which is here translated.

THE CUCKOO (CUCULUS CANORUS).

ON the 20th of last May, Dr. John Alex. Smith dissected a male Cuckoo, in full adult plumage, which had been shot in this neighbourhood a day or two before. The stomach, a musculo-membranaceous bag, with the proventriculus well defined, measured two inches in length and one and a half inches across, or in breadth; it appeared to contain a firm, rounded body, lying loosely in its otherwise empty cavity. On opening the stomach, the proventriculus was found filled with a mucous secretion, and a black oval-shaped body was seen, of a smooth and lubricated appearance; it measured one inch in length and about half an inch in breadth, and weighed 31 grains. When broken across, it was found to be of a lighter colour, and nearly dry internally, and consisted apparently

of the undigested remains of insects and larvæ, portions apparently of elytra, vessels, &c. It was evidently the indigestible parts of the food prepared for being ejected from the stomach by the mouth—a "pellet" or "cast," as it has been called, which is so well known in the case of the hawks and owls; and from the abundant secretion in the proventriculus, and empty state of the stomach, was apparently on the very point of being ejected by the mouth.

The fact was new to him as regarded the cuckoo, and he therefore noted it with interest. The lining membrane of the stomach showed no appearance, either to the naked eye or to the microscope, of the coating of hair, which has been often described, and which he had seen in other specimens; it is believed to be caused by the bird feeding on hairy caterpillars, perhaps at a more advanced period of the season; the intestines contained only a uniform smooth creamy-like matter. The testes were very small, being scarcely one-fourth of an inch in length, the largest like a very small pea. Several genera of birds, it is well known, eject the indigestible parts of their food as pellets. Sir William Jardine believes, that in addition to the Accipitres, the cuckoos, kingfishers, motmots, and bee-eaters, all do so. Macgillivray says—"I have never met with a fragment of the elytra, the articulation of a limb, or any other hard part of an insect, in the intestines of the cuckoo, the contents of which are of a uniform pulpy and impalpable mass of a light red colour. Of course, the remains of insects in the stomach must be thrown up in pellets, as in hawks and owls." Dr. Smith was able, therefore, to supply the positive side of the evidence, and by exhibiting the pellet from the stomach itself, put an end to any doubt that might have existed on the subject, at least in regard to the cuckoo.—*Proceedings of the Royal Physical Society.* (*Edin.*)

HABITS OF SEA-FISH.

M. Coste has described to the French Academy of Sciences, a kind of marine observatory which he has constructed at Concarneau (Finistèrre), for the purpose of studying the Habits and Instincts of various Sea-fish. A terrace has been formed on the top of a house on the quay, with reservoirs arranged like a flight of steps. The sea-water is pumped up to the topmost reservoir, and thence flows down slowly, after the manner of a rivulet, 50 centimetres in breadth, along all the other reservoirs, which together form a length of about 80 metres. This length is divided into 95 cells by wire-net partitions, which, allowing free passage to the water, yet prevent the different species of fish from mingling together. By this ingenious contrivance each kind lives separate, enjoying its peculiar food and habits unconscious of its state of captivity. Having described this apparatus, M. Coste gives an account of the results of his observations, which are both new and curious. Some species, such as the mullet, the stickleback, &c., grow perfectly tame, will follow the hand that offers them food, and will even allow themselves to be taken out of the water without attempting to avoid it. The goby and *bull-head* are less familiar; the turbot, which looks so unintelligent,

will nevertheless take food from the hand; it changes colour when irritated, the spots with which it is covered growing pale or dark according to the emotions excited in it. But the most curious circumstance concerning it is, that it swallows fish of a much larger size than would appear compatible with the apparent smallness of its mouth. Thus, a young turbot, not more than ten inches in length, has been seen to swallow pilchards of the largest size. The pipe-fish has two curious peculiarities. These fish form groups, entwining their tails together, and remaining immovable in a vertical position, with their heads upwards. When food is offered them they perform a curious evolution—they turn round on their backs to receive it. This is owing to the peculiar position of the mouth, which is placed under a kind of beak, and perpendicular to its axis. The crustaceous tribes have also furnished much matter of observation. The prawn and crab, for instance, may be quoted as exercising the virtue of conjugal fidelity to the highest degree; for the male takes hold of his mate, and never lets her go; he swims with her, crawls about with her, and if she be forcibly taken away from him he seizes hold of her again. The metamorphoses to which various crustaceans are subject have also been studied with much attention: M. Coste finds, for example, that all the Zoea hitherto described by various authors are but the larvæ of brachyurous decapodes, and not, as has been supposed, the embryos of crabs or lobsters.

ON AQUARIA.

MR. N. B. WARD, in a paper read to the British Association, has considered the application of those principles which had proved so successful with plants to the subjects of the animal kingdom. At the meeting of the Association at Liverpool, in 1838, he directed the attention of the members to the extension of his principle to animals. He felt quite certain that a great number of animals would live and thrive under the same treatment; and he could see no reason why, at the same time that our stoves were ornamented with Rafflesia, they might not be illuminated with Fulgoras and Candelarias. In the same year he addressed a letter to Sir W. Hooker, in which he expressed his belief that animals as well as plants might be imported in the case; and these views were stated by Professor Faraday at the Royal Institution. In 1841 he established the first aquarium for fish and plants in his fern-house in Wellclose-square, his object being *not* to determine the counterbalancing influence of plants and animals in water—that having been ascertained long before by Priestley—but to determine whether the limited quantity of air in the fern-house would be sufficient for the well-being of the fish. This plan was shortly followed by Dr. Bowerbank in a large glass jar, which, when seen by Mr. Mitchell, occasioned the construction of the Vivaria in the Regent's Park. Mr. Ward then proceeded to read a very interesting communication from Mr. Mummery, detailing his experiments on marine animals and plants during his residence at Dover, illustrated by some very

beautiful representations of some of the animals which were living in his aquarium. Of the permanent inhabitants were the following:— Actinia crassicornis, A. gemmaria, A. anguicoma, A. Dianthus, A. miniata, A. bellis, A. nivea, A. mesembryanthemum, Sertularia planula, Bowerbankia densa, Pedicellina belgica, Tubularia indivisa (in various states), Aphrodite aculeata, Serpula contortuplicata, Pagurus Bernhardi, Portunus puber, Balanus balanoides, Buccinum undatum, Patella, Œolis lineata, Palæmon. The three following could only be kept for a very few days: Lepas anatifer, Cydippe pileus, Lucernaria auricula. Mr. Ward then gave a glowing description of the coral reefs of Rottenset Island, Western Australia, by Dr. Harvey, of Dublin, and strongly advocated the importation from thence of some of the beautiful forms of vegetable life, such as Caulerpa, Bypsis, &c.

The paper was illustrated by a collection of cultivable sea-weeds from the herbarium of Dr. Harvey, of Cork, and a series of coloured diagrams of animals inhabiting aquaria, by Mrs. Mummery.

Dr. Lankester referred to the importance of many remarks that had been made on the habits of animals domesticated in aquaria. He stated that he had recently seen a beautiful specimen of the jelly-fish Rhizostoma, which had been kept alive in sea-water in London for a week; and he believed that with care other species of this beautiful family might be domesticated and their habits watched. He stated that he had taken this year large numbers of the *Lucernaria auricula* at Felixstow, where he had never seen a specimen before.

Mr. Deane hoped that more observations would be made on the groups of animals and plants that could be kept together, as now frequently the plants grew so rapidly, especially the Confervæ, as to prevent the animals being seen.

PISCICULTURE.

M. Coste has presented to the French Academy of Sciences, some specimens of Trout hatched at the College de France, and then transferred to a pond in the Emperor's domain of Villeneuve-l'Etang, near St. Cloud. The trout of one year old in that pond were about 20 centimètres in length, and between two and three ounces in weight; so that, in the Paris market, they would fetch from 1f. to 1f. 25c. each. Those of the age of 33 months were between 45 and 50 centimètres in length, and weighed from 1 lb. to 2 lb. and more, so that their marketable value was between 3f. and 6f. They were so numerous in the small piece of water where they had been reared, that it became impossible to fish them with a dredging-net without killing some, so that a casting-net had to be used. M. Coste added, that they had had no other nourishment but worms, insects, and tadpoles.

IMMENSE "TAKE" OF SALMON IN THE TWEED.

On July 26th, 1858, owing to the "spate" which came down on the previous *morning*, the net-fisheries on the Tweed had the largest *take of Salmon* ever remembered by the oldest fisherman to have been

caught in the same space of time in that river. From six o'clock in the morning, when the fishing commenced, till night, about 3500 adult salmon, and about half the number of grilses (*i. e.*, upwards of 5000 in all), with a fair proportion of trouts, were taken. At several fisheries in the middle district more salmon were caught than are usually taken during an entire season. Wilford and Beadibus waters (about five miles up the river) had 600 fish each. Large numbers got beyond the netting district.

OYSTERS.

MR. T. C. EYTON has read to the British Association a further "Report on the Oyster," continuing that which he began at the Meeting of the British Association held at Cheltenham. At that meeting he exhibited the young oyster taken from the beard of the parent. He now traced the young oyster from the embryo state in the ovary to its perfection at five years old; and exhibited a series of drawings made for a work on the history of the oyster, the mode of preserving the beds and increasing their productiveness, shortly to be published by Mr. Van Voorst. For an Abstract of Mr. Eyton's previous Report, see *Year-Book of Facts*, 1857, pp. 227-228.

CRAB DISSOLVING SHELLS.

DR. GRAY has read to the Zoological Society, a paper "On the Power of Dissolving Shells possessed by the Bernard Crab." In a note to his paper "On the Formation and Structure of Shell," in the *Philosophical Transactions* for 1853, he stated it as probable that some Bernard Crabs had the faculty of dissolving shells, it not being unusual to find the long fusiform shells which are inhabited by these animals with the inner lip and a greater part of the pillar on the inside of the mouth destroyed, so as to render the aperture much larger than usual. Dr. Gray having continued his observations on these shells, is quite convinced that certain species of the Bernard Crab (*Pagurus*) have this power; some possess it to a much greater degree than others.

MICROSCOPIC EXAMINATION OF THE INTEGUMENT OF CRUSTACEA.

IN order to arrive at more certain results in the identification of species, Microscopic Examination of the Surface of the Integument will be found peculiarly useful. This mode of examination of species may be applied to a considerable extent throughout the crustacea generally with great advantage; and if found valuable in recent, there can be no doubt that it will prove of far greater importance in extinct, forms, where facts on which the identification of species usually rests are lost, and fragments only of the animal obtainable. It should be borne in mind, however, that as the structure in question undergoes modifications more or less considerable in different parts of the animal, it will always be advisable to compare the corresponding parts with each other.

Applying this test to the known species of *Galathea*, we perceive that the structure of the integument upon the arms exhibits a

squamiform appearance, but that the scales which characterize the structure possess features peculiar to each species. Thus in *G. strigosa*, the scales are convex, distant from each other, smooth at the edge, and fringed with long hairs. In *G. squamifera* they are convex, closely placed, scolloped at the edge, and without hairs. In *G. nexa* the scales are obsolete, tufts of hair representing the supposed edges.—*Spence Bate, Proc. Linn. Soc.*

RARE ZOOPHYTE.

DR. STRETHILL WRIGHT has placed before the Royal Physical Society several rare Zoophytes, amongst which was the *Myriothela Urtica*, of Sars. He states that the animal is not naked, as described by Gosse, but has a distinct horny corallum; nor are its tentacles wart-shaped; they resemble the tentacles of corone, except in having sting-cells of smaller size. According to Mr. Cooks, of Falmouth, the young of Myriothela is furnished with long processes or *legs*, on which it moved from place to place as its erratic fancy led it. But after some time it forsook its wandering life, cast off its *legs*, developed tentacles, fixed itself to a stone, and devoted itself to the more staid occupations of providing itself with food, producing a family of young ones, and stinging those of its marine neighbours who came into collision with it.

SYNAPTA.

MR. S. O. WOODWARD has read to the Zoological Society a paper "On the genus Synapta," by himself and Mr. L. Barrett. Two species of Synapta (marine animals, remarkable for the microscopic anchors in the skin) are found on the British coast: 1. *S. digitata* (Mont.), ranging from Scotland to the Mediterranean, occurs in Rothsay Bay, West Coast of Ireland, Devonshire, Cornwall,—also in Vigo Bay, Galicia, and Trieste, Adriatic; 2. *S. inhærens* (Mull.), which ranges from Norway to Brittany, has been found at Aberystwith, Criccieth, Falmouth, and Bantry Bay. A new species, called *S. bidentata*, was described as having bifid anchor flukes, and oval plates perforated by many circular holes decreasing in size from the centre to the circumference. The specimens were collected in China by the Rev. G. Vachell, and were three inches long, with twelve tentacles, each having four lobed digits.

ELECTRA VERTICILLATA.

MR. HOLDSWORTH has read to the Zoological Society a paper "On Electra Verticillata," and directed attention to a remarkable variation in its mode of growth, found by him abundantly on the coast of Portugal, and, although alluded to by several naturalists, has never been fully described. This variety consisted in the production of clusters of narrow ribbon-shaped fronds from the encrusting cylindrical form usually figured, each ribbon being composed of a double layer of connected opposite cells placed in parallel transverse rows.

FRESH-WATER POLYZOA.

LIEUTENANT MITCHELL, at a late meeting of the Madras Asiatic Society, observed, that Professor Allman, in his recent work, entitled *A Monograph of the Fresh-water Polyzoa*, had stated, that although found at an altitude of 6000 feet, these Infusoria had not yet been met with beyond the limits of the temperate zone. Now, Mr. Mitchell has himself taken them in Madras, and gives a very interesting description of one he captured in considerable numbers adhering to the roots of the common duck-weed or Lemna in the month of September. These, when placed in a polyp-trough, under a one-inch objective, exhibited groups of Polyzoa inhabiting tubular cells attached to the root of the plant and to each other. The head of the animal, which was transparent and hyaline, and furnished with a double row of cilia upwards of forty in number, was protruded from the cell in the act of feeding, and the whole process of capturing, swallowing, and digesting its prey, was distinctly visible. It seemed to prefer the smaller kind of Infusoria, rejecting the large Rotatoria, which were drawn into the vortex of the cilia by their rapid motion, an operation which it effected either by driving off the intruder by blows of the tentacula, or, if this failed, by retiring into the cell when the vibratile action of the cilia was suspended, and the unwelcome visitor escaped. Mr. Mitchell believes that both this and other species will be found abundantly on the roots of Lemna and other fresh-water aquatic plants.

ACTINIÆ.

MR. WARINGTON has read to the British Association a paper "On the Multiplication of Actiniæ in his Aquaria." He described a process of reproduction occurring amongst these creatures, in which a portion of the base becoming separated from the Actinia, split up into three or four portions, each giving rise to a new Actinia.

The reading of this paper caused considerable discussion, in which Dr. Wright, Mr. Barrett, and the Rev. T. H. Hincks took part. The question was as to whether the reproduction spoken of by Mr. Warington could be regarded as a true gemmation, or the result of the passage of ova into the separated parts which afterwards became young Actiniæ.

At a meeting of the Dublin University Zoological and Botanical Association, Dr. M'Donnell has stated in reference to the urticating organs of the Actiniæ, and on the spasmodic action caused by them when suffered to touch the nerves of a frog prepared for electrical experiments, that at one time he had thought this was caused by electricity generated in these animals; but that further experiments and the use of a very delicate galvanometer had caused him to abandon this view, and to ascribe these movements to the local *irritation caused* by the poison contained in the thread cells of the *Actiniæ.*

EFFECT OF STRYCHNIA ON REPTILES.

MR. G. MORLEY has submitted to the British Association a Frog in a rigid state from Strychnia, and one which had passed from that to apparent death; and then pointed out that in the animal which had apparently expired, pulsation and circulation were going on more rapidly than in the one in a state of rigidity. He thought the animal dead in the early experiments, but from the free hæmorrhage discovered that it was not; and this led him to see the importance of the discovery in making observations on the circulation.

ON THE CELLS OF BEES.

AT the late Meeting of the British Association were communicated the following interesting papers:

Dr. Wright read a paper "On the Formation of the Cells of Bees," by Mr. W. B. Tegetmeier, who writes: Having recently been engaged in making a series of experiments with a view to determine the typical form of the cells of bees, and having arrived at some interesting results, I am desirous of bringing them before the members of the British Association. My first experiment consisted in placing a flat parallel-sided block of wax in a hive containing a recent swarm. In this, cells were excavated by the bees at irregular distances. In every case where the excavation was isolated it was *hemispherical*, and the wax excavated was added at the margin so as to constitute a *cylindrical* cell. As other excavations were made in contact with those previously formed, the cells became flat-sided, but from the irregularity of their arrangement not necessarily hexagonal. When the block was coloured with vermilion, the employment of the excavated wax in the formation of the sides of the cells was rendered more evident. The experiment has been repeated with various modifications as to the size and form of the block of wax, but always with the same results,—namely, that the excavations were in all cases hemispherical—that the wax excavated was always used to raise the walls of the cells—and that the cells themselves, before others were formed in contact with them, were always cylindrical. Mr. Charles Darwin, to whom I communicated these facts, has repeated the experiments with similar results. When these experiments are taken into consideration, in connexion with the facts that in the commencement of a comb the rudiments of the first-formed cells are always hemispherical, and that in a small extending comb the outer sides of the bases of the external cells are always circular, they appear to lead to the conclusion, that the typical form of a single cell is cylindrical, with a hemispherical base; but that, when the cells are raised up in contact with one another, they necessarily become polygonal, and if regularly built, hexagonal. On this supposition alone can those numerous cases be accounted for in which one half of a cell is cylindrical, the other polygonal. In all such cases it will be found that, in the cell adjacent to the cylindrical side, there is not room (owing to some irregularity of the comb) for a bee to work,—consequently, the cylindrical development is not interfered with. The formation of the small cylindrical cells surrounding the

queen cell appears to admit of no other explanation. The mode in which the circular bases situated at the thin edge of a comb in the process of enlargement become converted into polygonal cells as new bases are formed on their outer sides, has been beautifully shown by Mr. Darwin. In repeating, with many ingenious modifications, my original experiments, he coloured, with vermilion and wax, the circular edges of the bases of the external cells in a small comb. On replacing this in the hive, he found that the walls of the cells were not raised directly upon these circular bases, but that, as other cells were built external to them, the coloured wax was remasticated and worked up into the polygonal sides of the cells—consequently, the colour, instead of remaining as a narrow line, became diffused over a considerable portion of the sides of the cells. These observations have been much facilitated by the employment of a hive having each side formed of four parallel plates of glass, with thin strata of air between. As thus formed, the escape of heat is so effectually prevented that the bees work without the necessity of covering the hive with any opaque material, and thus they are always open to observation without being disturbed by the sudden admission of light into a hive previously dark. Crude and imperfect as these experiments may be, they appear to me to have an important bearing on the theory of the formation of cells, and my desire that they may be repeated and extended by other observers must plead my excuse for bringing them before the notice of the Association.

Dr. Whewell communicated some observations from Mr. Ellis, "On the Cause of the Instinctive Tendency of Bees to form Hexagonal Cells." He supposed that bees were led to the exercise of this instinct by the use of their organs of sight. It was well known that, in addition to their facetted eyes, they had three single eyes; and he supposed that these eyes were placed in such a position as to enable them to work within such a range as to give the walls of their cells an angle of 120 degrees.

Mr. J. Lubbock gave an account of the experiments by Mr. Darwin, in which he had found that bees made circular cells in the circumference of their combs, but that these were always worked again into an hexagonal form when another row was placed beyond them. That the material of the circular cell was removed for this purpose he had ascertained by painting the outside of the external row of cells with carmine, indigo, and other substances, which were invariably worked up into the next row of cells. In answer to Mr. Ellis's theory of the eyes, he could state from observation that bees in ninety-nine cases out of a hundred worked in the dark. Wasps made hexagonal cells from the beginning. He believed the tendency of bees to make hexagonal cells was acquired, and that originally bees made circular cells, but from a deficiency of material had at last acquired the habit of making hexagonal cells.

Mr. Bayldon stated that he kept a large number of bees, and that *he had seen* them make hexagonal cells at first. The outer cells *alone* were circular.

Dr. Lankester said it was an interesting physiological question as

to whether the eye or some other organ was the first recipient of the impression which induced the movements that resulted in the bees' work. An impression must be made on some organ of the animal, as all the actions of the lower animals were excito-motory, and probably the antennæ were the organs acted on.

Dr. Edwards suggested that the materials with which the bee worked were sufficiently receptive of light to act upon their organs of vision, and thus the eye might be still the excitor of the instinctive actions.

Lord Brougham has read at the French Academy of Sciences, a paper entitled "Analytical and Experimental Inquiries on the Cells of Bees," the object of which was to point out the errors into which both mathematicians and naturalists have fallen on the subject, and to show that they have entirely misunderstood many acts of the bee, and fallen into error in their manner of accounting for the same.

BEE TAMING.

A SWARM of Bees from a neighbouring apiary settled upon the window of a shop in one of the leading thoroughfares in Morpeth; the master of the shop, however, who possessed some knowledge of bees, in the course of a very short time had the entire swarm rendered perfectly quiet and manageable by the application of chloroform. Having by this ingenious device been made completely harmless, they were carefully parcelled up and delivered to the owners. It may not be generally known that by the application of chloroform bees may be rendered quiet and innocuous; and, while in this state, that the honey may be taken from them—a process which, it must be allowed, is much less revolting than the common practice of destroying them altogether.—*Northern Daily Express.*

NEW BEEHIVE.

MR. SEDGMUIR has exhibited to the Entomological Society, a Beehive of his own construction, consisting of two or more boxes placed on each other, and provided with moveable bars, which are kept in their position by slides between them fitting into grooves in the sides of the bars, and affording the utmost facilities for the removal of any portion of the comb.

EXTRAORDINARY WASPS' NEST.

IN the Ashmolean Museum at Oxford may be seen at the present time a nest of the common wasp (Vespa Vulgaris), of extraordinary dimensions. It was taken out of the ground at Cokethorpe Park, Oxon, on the 18th of July last, by Mr. Stone, of Brighthampton (who has made many very highly interesting observations on the habits of wasps), being at that time 6 inches in diameter; it was then hung up in the window of an old house, being suspended by a wire a foot in length. The wasps seemed to have no confidence in this support and ran up from the top of the nest to the support above, a column about three inches in diameter, evidently with the intention of strengthening their position. This column was broken

away two or three times, and as often rebuilt by them, but at last, to prevent their doing so any more, the wire was greased. Being disappointed by this means of support from above, they then formed a column about the same size and length downwards, to support the nest from the window-sill, and to prevent their attaching in this manner the next day it was swung clear off the window-sill, and the new appendage broken off; after which they seemed content with the strength of the wire, and went on enlarging the nest in the ordinary way. The gigantic size is to be attributed to the fact that the wasps were constantly supplied with a mixture of sugar and beer, their daily consumption during the height of the season being a pound of the former and a pint of the latter. This was the primary cause, but not the only one, for out of it sprang another, which was productive of greater effect. Two other nests of this species having been procured and placed in a room on the first floor, the wasps, finding themselves not so well treated with reference to rations, &c., as their more fortunate neighbours on the ground-floor, began towards the end of August to desert in vast numbers, and join the favoured community below, permanent members of which they were allowed, without the least show of opposition, to become. This immense addition to the ordinary number of wasps of necessity continued to swell the work far beyond its ordinary limits. The height of this huge nest is 27¾ inches, and the circumference 63 inches.

SILK FROM VICTORIA.

HOPES, it appears (says the *Australian and New Zealand Gazette*), are entertained of a new branch of export of rather a novel character; for it is stated that a native variety of the Silkworm may be found in the bush of Victoria, clinging in countless swarms to the shrub which forms its food. The worm is enclosed in a dark-coloured cocoon, the exterior of which is of extraordinary toughness, and encloses a quantity of yellowish silk. The staple of this, both as regards its fineness and length, has been pronounced by a manufacturing house in Glasgow, by whom it was tested, superior to the product of the best European worms. The cocoons are found in extraordinary abundance.

Mr. Gerard Krefft, who has recently returned from Australia, has communicated to the *Times* the following remarks regarding the silk-producing insects of that country:

1. The cocoons containing silk which ever came under my observation, were generally found deposited under the loose bark of Eucalyptus rostrata, Schl., or Eucalyptus acuminata, Hook, the flooded gum tree of the colonist, and are the productions of a large hairy caterpillar, from two to three inches in length, which feeds on various shrubs, and eventually selects the bark of the flooded gum-tree for its transformation into the cocoon.

I have kept one of these caterpillars in a box, and after it had *spun itself* in I removed the silk. The next morning the insect had *surrounded itself* afresh; again I disturbed it, only to find it *enclosed in a* new shroud twelve hours afterwards. Specimens of the

moth are at the Melbourne Museum. This caterpillar or silkworm is distributed over a great tract of country. I have found it along the banks of the Murray from Maidens Punt to the Darling junction, and about 100 miles along the bank of this river.

Although cocoons are plentiful, I rather doubt that "two hours devoted to the work of collection" would produce 2 lb. of raw silk, and I should consider it a fair day's work to gather from 3 lb. to 4 lb. of cocoons, as they weigh very light indeed.

2. There is also a silver-gray spider, with thin round body and long cherry brown legs (not hairy), spinning its meshes among the bushes of the Murray scrub, and the silk produced by this insect far surpasses in strength and glossiness the silk of the caterpillar before mentioned.

Riding through the scrub my progress was sometimes impeded by the web of this spider, which often covered an area of several square yards, the threads being so strong that they never broke at the first attempt to push through.

Specimens of this spider are to be found at the Melbourne Museum, as also a quantity of silk presented by Mr. Surveyor Kerr. I beg to state that my observations were made when in charge of a collecting party fitted out by the Victorian Government.

DISEASE OF THE SILKWORM.

THE following facts have been laid before the French Academy of Sciences, by MM. Decaine, Peligot, and de Quatrefages, members of the committee appointed to investigate the cause of the diseases of the Silkworm, and seek a remedy for it. These gentlemen, having visited various parts of France, found the mulberry leaves in excellent condition, so that there is no foundation for the opinion which attributes the disease to bad food. Of all the diseases to which the silkworm is subject, the most frequently met with is known by the name of *pattes noires*, or *poivré* in France; M. de Quatrefages proposes to call it the *maladie de la tache*, from the spots which appear on the worm when attacked with it. These spots are often invisible to the naked eye, and can only be perceived with the aid of a magnifying glass; and this circumstance explains why the malady, especially during the past year, escaped the observation of silk-growers in the majority of cases until five or six days after the worm had cast its fourth skin. The spots exist in all the tissues and organs of the worm, and in its subsequent stages of a chrysalis and moth. In the latter, the spots destroy the antennæ, the legs, or a portion of the wings. In the beginning, the spot appears under the form of a yellowish matter pervading the whole system; this matter gradually becomes darker, and is then concentrated into a number of tubercles, which are the spots in question. That such a diseased state should exercise an influence on the quality of the eggs is not surprising, but to what extent can only be determined by future experience. An infected silkworm may spin its cocoon when the disease is not too far gone, but the insect generally dies, and the body, *instead of putrefying*, becomes dry and brittle. M. de Quatrefages

has tried several methods of cure: first, the hygienic process, which consists in rearing the worms in open sheds instead of close rooms. The leaves of the wild mulberry, not stripped from the branches, he has found very efficacious. He strongly recommends silk-growers to rear small lots of worms apart from the others, solely for the purpose of propagating the species. But, besides these precautionary measures, partly recommended by others, he has had recourse to new remedies not hitherto recommended, and has endeavoured to administer various medicines to the worms. From his experiments it appears that the silkworm does not refuse to eat the leaves of the mulberry sprinkled with Peruvian bark, gentian, valerian, mustard, &c., and the two latter powders especially would seem to produce good effects. But scraped sugar appears, for the present, to be preferable to all other remedies. The worms eat the leaves sprinkled with sugar with extraordinary relish, and the experiments with this substance were accordingly repeated on a larger scale in the establishment of M. Augliviel in the department of the Gard, where one of the silk sheds fitted up for twenty-seven trays was reduced by disease to four. The worms of these were transferred to another shed, and divided into four lots; the first was fed in the common way, the second with moistened leaves, the third with sugared leaves, and the fourth was subjected to a rigorous abstention of food for seventy-five hours, and then fed chiefly with sugared leaves. At the end of twenty-four hours, several worms of the latter lot began to spin, and made several small and imperfect cocoons on the tray; the other worms began to shrivel up and diminish in size; but on receiving the sugared leaves, they speedily rallied, and many of them spun their cocoons. The worms fed with moistened leaves fared very badly, and very few of them spun cocoons. Those fed in the common way presented nothing remarkable, and yielded a certain quantity of cocoons; but those fed with sugared leaves throve well, and spun their cocoons sooner than the others. The quantities of silk yielded by these four lots were respectively: 1st lot, 210 grammes; 2nd lot, 0; 3rd lot, 392 grammes, and of a superior quality; 4th lot, 152 grammes. Now, when it is considered that such a result was obtained from the use of sugar on worms, the state of which was hopeless, it may reasonably be concluded that its effect will be much more satisfactory in less desperate cases. At all events, one fact has been put beyond a doubt—viz., that medicine may be administered to silkworms in the same way as it is administered to cattle and poultry.

GLOW-WORMS.

DR. LANKESTER has exhibited to the Meeting of the British Association three living Glow-worms, which had been sent, by post, to Lord Enniskillen, from Mr. Fisher, of Ely, who has succeeded in keeping glow-worms alive by feeding them on small snails, (*Helix nitida*,) and suggests that glow-worms should be employed for keeping down the snail. Dr. Lankester suggested that many

people would be glad to use the snail for the purpose of keeping the beautiful worm alive.

NEW ONISCOID.

THE Rev. Mr. Hogan has read to the Dublin University Zoological and Botanical Association, a paper "On the Occurrence of a new British Oniscoid inhabiting Ants' Nests," the author observing that the new oniscoid was found at Lulworth Cove, Dorsetshire, last September, in the nests of three different kinds of ants, but it was more abundant in the red ant's nest. These crustaceans seemed familiar with the winding chambers and subterranean galleries of the formicarium, and the ants did not carry them off as they did other beetles. There were generally eight or nine in a nest.

BLIND BEETLE.

MR. S. SAUNDERS has exhibited to the Entomological Society two specimens of *Leptoderus Hohewartii*, one of the blind beetles from the Proteus Cave, at Adelsburg, in South Austria, where the specimens were found by him in the deepest part of the cavern.

LEAD PERFORATED BY INSECTS.

IN September, 1857, Marshal Vaillant presented to the French Academy of Sciences some bullets which had been brought back from the Crimea, perforated by an insect unknown in France, stating at the same time that he had applied to St. Petersburg for information on the subject. He has communicated the result of his inquiries to the Academy, in a paper by M. de Motschulsky, of which the following is an abstract:—1. The phenomenon of the perforation of bullets has not been observed in the Russian army. 2. The insect which caused them in the bullets of the French army is the larva of the *Urocerus juvencus*. (Lin.) 3. This insect has not hitherto been met with in the Crimean peninsula by Russian entomologists, and appears to be very rare even in Russia Proper, but is common in Bessarabia, Germany, Sweden, and England, where it does much mischief to the fir and pine forests; in France it has been met with in the Jura. M. Hartig has described it at some length in his work on the *Tenthedinidæ*. 4. The urocerus which perforated the French bullets was imported from France in the wood of which the boxes containing the cartridges were made. 5. The urocerus corroded the lead with its mandibles in order to lay its eggs in the cavity, but in so doing it did not satisfy any peculiar craving for that metal, but merely operated upon it as it would have done on wood, having been forced to do so because the bullet lay in its way. 6. The larvæ of the urocerus did not feed upon the lead which they had scraped off with their jaws, and the perfect insects could not feed upon it either, since they were found dead in the galleries bored by the larvæ.—*Daily News*, July 9, 1858.

BOTANY.

ACTION OF THE SOIL ON VEGETATION.

THE late Professor Gregory left the following summary of Recent Views relative to the Action of Soil on Vegetation :—

1. Way, and after him Liebig, have shown that every soil absorbs ammonia, and also potash, from solutions containing them or their salts, generally leaving the acid, which takes up lime, &c. from the soil in solution. The ammonia and potash, which are absorbed in very large proportion by arable soils, are rendered thereby quite *insoluble.*

2. Arable soils absorb also silicic acid in very considerable proportion, and it also becomes insoluble.

3. Arable soils also absorb the phosphoric acid of phosphate of lime, or of ammoniaco-magnesian phosphate, apparently soluting the acid, which also becomes insoluble.

4. Hence the soluble ingredients of manures *cannot* be conveyed to the plants in the form of a solution percolating the soil (such as liquid manure, or a solution formed by rain-water with the aid of carbonic acid), since such a solution is deprived of its dissolved ingredients by filtering through a very moderate amount of soil.

5. Hence, also, as the food of plants must thus be fixed in the soil in an insoluble form, it is plain that it can only enter the plant in virtue of some power or agency in the roots, which decomposes the insoluble compounds in the soil, and thus renders soluble the necessary matter.

6. The absorbent power of soils is partly chemical, and partly mechanical, as is the case with charcoal.

7. The quantities of alkalies, of phosphates of ammonia, &c., capable of being supplied to plants by rain-water, after it has percolated through the soil, even supposing the whole to be assimilated, does not amount to more than a *mere fraction* of what the plants contain.

8. The theory of the transference of ammonia, potash, silica, phosphates, &c., from the soil to the plant is not yet understood; but the old theory, that the rain conveys food to the plant directly, is certainly not the true one.—*Edin. New Phil. Journal*, No. 15.

IRISH TURF.

MR. N. B. WARD has exhibited to the Linnæan Society, a specimen of white or fat Turf from the island of Valentia, in Ireland. In a letter which accompanied the specimen it was stated, that "in some parts of the west of Ireland this turf is found under the black turf, and resting on clay. When wet it is tough and unctuous, but becomes of a light corky character on drying; it is very inflammable, and the smoke from it is quite aromatic." Mr. R. J. Lecky, by whom the sample was communicated, inquires if its aromatic properties can be attributed to the *Myrica Gale?*

THE VINE DISEASE.

new and important facts form the subject of a

paper presented to the French Academy of Sciences by M. de la Vergne :—"1. The oïdium does not spread to any alarming extent, except when the temperature is day and night above 20° Centigrade (68° Fahr.), as is the case in the neighbourhood of Bordeaux, from the end of May to that of September. Whenever northern winds prevail in the interval, or frequent rains lower the temperature considerably, the growth of the oïdium is stopped, to acquire fresh vigour as soon as the sun adds warmth to the humidity with which the parasite is saturated. The same vine plant is not always equally subject to the attacks of the oïdium, nor at the same time of the year; nor are different species of vines equally invaded in different soils or situations. Hence, the operation of sulphuring need not extend to every point attacked, or be repeated during the whole duration of the malady.

"2. The action of the sulphur is circumscribed, and almost strictly local. Its curative properties have no effect below the temperature of 20°; hence the warmth necessary for its action is precisely that which favours the growth of the oïdium. As wind and rain carry off the sulphur, this substance can only protect the vine during a limited period. Moreover, it does not restore grapes already spoilt to their normal condition. But sulphur destroys the shoots of the oïdium of recent formation, and thus prevents it from spreading. It is a great mistake to think that too much sulphur cannot be administered to a vine; the particles of flower of sulphur contain minute portions of sulphuric acid, which, when accumulated to excess, will burn the plant itself, often injuring it irretrievably. Fifty kilogrammes of sulphur per hectare, if properly administered, are quite sufficient for a season.

"3. As the vine-growing districts of France are deficient in hands, it becomes a matter of importance not to increase the labour of cultivation unnecessarily by untimely sulphuring. No vineyard is attacked by the oïdium at once throughout its whole extent; there are always some vines that are the first to betray the existence of the enemy, and it is they that point out the proper time for sulphuring. They are generally situated near buildings or ditches, or trees casting a shade over them. Whenever a whitish or farinaceous spot appears on the leaves or stem of these plants, in a temperature exceeding 20° by night as well as by day, it is certain that all the vines are attacked, although the eye cannot discover a trace of the fungus elsewhere, and then every plant of the vineyard must be sulphured at once."

A few practical remarks have been published by the Committee of the *Accademia dei Georgofili* of Florence, appointed to inquire into the results obtained from sulphur during the years 1856 and 1857. The committee state in their report that although the oïdium appeared in those years to be naturally on the decline, yet the beneficial effects of sulphur could not be denied. The operation was conducted with more or less care in different localities, which circumstance *accounts* for the different degrees of success obtained. *The wines were excellent*; the slight sulphurous taste they sometimes *had disappeared in* a short time. The washing of the grapes im-

mediately after the tying of the vines with from 5 lb. to 7 lb. of glue dissolved in 100 lb. of water, and with the addition of a little flour or clay, had produced excellent effects. Laying the vines down, so as to bring the grapes as near as possible to the ground, had also been found advantageous. Lastly, the report mentions the curious fact that the grafting of American vines upon those of Tuscany produces a great increase in the quantity of grapes, and that vines so grafted are little liable, if at all, to be invaded by the oïdium. But this system is attended with two serious drawbacks—the wine-grower loses the produce of two years, and the wine obtained, though extremely abundant, is inferior in quality.—*Galignani's Messenger.*

GUTTA PERCHA OF SURINAM.

PROFESSOR BLECKROD, of the Delft Academy, has recently given a notice of the Gutta Percha of Surinam. Although gutta percha has been known in Europe for a dozen years, and has now come into general use, yet much still remains to be done regarding it, both as respects its uses and its sources. The Professor states that Dutch Guiana can supply gutta percha. This is of importance, when we consider the value of the article, and the probable exhaustion of it in the countries from which it is now supplied. The Dutch Government took measures to transplant the *Isonandra Gutta* and cultivate it in Guiana; but they have lately discovered in that country a species of Sapota, to which Blume gives the name of *Sapota Mulleri*, which yields a juice in every way equal to that of the Isonandra. It is probable that other trees of the same natural order may be found to yield a similar product. *Achras Sapota*, the fruit of which is known in the West Indies as Neesbery, also yields a milky juice like gutta percha. *Sapota Mulleri* of Blume is probably the tree called "Bullet-tree" by the English, and its wood is known as "horse-flesh." It is a tall tree, yielding in summer a large quantity of milky juice. It appears that under the name common Boerowe, or Bullet-tree, there have been confounded: 1. The *Lucuma mammosa* of Gærtner (Marmalade tree)—the Mimusops of Schomburgk; 2. The white Boerowe; which is the *Dipholis salicifolia* of Alph. D.C., and is known in Jamaica as Galimata; 3. The bastard Boerowe or Lowranero, which is the *Bumelia nigra* of Swartz; and 4. The Neesbery Bullet-tree, or *Achras Siderexoylon* of botanists, which yields one of the best of the Jamaica woods. *Sapota Mulleri* grows abundantly on slightly elevated situations. In collecting the milk, the trunk is surrounded with a ring of clay, with elevated edges, and then an incision is made in the bark as far as the liber. The milky juice flows out immediately, and is collected in the clay reservoir. The juice resembles in some respects the milk of the cow. It forms a pellicle on its surface, which is renewed after removal. By the evaporation of the juice, we obtain 13 to 14 parts in 100 of pure gutta percha. This Surinam gutta percha is said to be sold at Amsterdam at the same price as the best gutta percha of commerce.—*Edin. New Phil. Journal*, No. 14.

Geology and Mineralogy.

RECENT PROGRESS OF GEOLOGY.

THE President of the Section of Geology, Mr. W. Hopkins, at the late Meeting of the British Association, remarked: The existence of mammalian life in its earlier stages on the surface of our planet, the condition of its existence, and the period of its introduction, have always furnished questions of the highest philosophical as well as palæontological interest. You will be aware that some geologists regard each new discovery of mammalian remains, in formations preceding the older tertiaries, as a fresh indication of the probable existence of mammalia in those earlier periods in which no positive proof of their existence has yet been obtained; while others regard such discoveries only as leading us to an ultimate limit, which will hereafter define a period of the introduction of mammalia on the surface of the earth, long posterior to that of the first introduction of animal life. Be this as it may, every new discovery of the former existence of this highest class of animals must be a matter of great geological interest. An important discovery of this kind has recently been made, principally by the persevering exertions of Mr. Beckles, who has detected in the Purbeck beds a considerable number of the remains of small mammals. The whole of them are, I believe, in the hands of our President, Professor Owen, for the determination of their generic and specific characters; but Dr. Falconer seems already to have recognised among them seven or eight distinct genera, some of them marsupial, and others probably placental, of the insectivorous order. I may also notice, as a matter of great palæontological interest, the recent discovery of a new Ossiferous Cave, near Brixham, in Devonshire, of which some account is to be brought before us during this meeting. The past year has been fruitful in palæontological researches. The subject of the motion of glaciers is one of interest to geologists, for unless we understand the causes of such motion, it will be impossible for us to assign to former glaciers their proper degree of efficiency in the transport of erratic blocks, and to distinguish between the effects of glacial and of floating ice, and those of powerful currents. An important step has recently been made in this subject by the application of a discovery made by Mr. Faraday, a few years ago, that if one lump of ice be laid upon another, the contiguous surfaces being sufficiently smooth to insure perfect contact, the two pieces in a short time will become firmly frozen together into one continuous transparent mass, although the temperature of the atmosphere in which they are placed be many degrees above the freezing temperature. Dr. Tyndall has the merit of applying this fact to the explanation of certain glacial phenomena. There are two recognised ways in which the motion of a glacier takes place: one by the sliding of the whole glacial mass over the bed of the valley in which *it exists; and the other* by the whole mass changing its form in

consequence of the pressure and tension to which it is subjected. The former mode of progression is that recognised by the sliding theory; the second is that recognised by what has been termed the viscous theory of Professor Forbes. The viscous theory appeared to be generally recognised. Still, to many persons it seemed difficult to reconcile the property of viscosity with the fragility and apparent inflexibility and inextensibility of ice itself. On the other hand, if this property of viscosity, or something of the kind, were denied, how could we account for the fact of the different fragments into which a glacier is frequently broken, becoming again united into one continuous mass? Dr. Tyndall has, I conceive, solved the difficulty. Glacial ice, unlike a viscous mass, will bear very little extension. It breaks and cracks suddenly; but the separate pieces when subsequently squeezed together, again become by regelation (as it is termed) one continuous mass. After some general remarks on the cause of the laminous structure of glaciers, during which he remarked that there was no doubt Dr. Tyndall was right in supposing the laminæ of blue and white ice to be perpendicular to the directions of maximum pressure, he said that it remained to be decided whether the explanations which had been offered were correct; but the actual perpendicularity of the laminæ of ice to the directions of maximum pressure within a glacier, and the probable perpendicularity to those directions of the laminæ in rock masses of laminated structure, would seem to establish some relation between these structures in rocks and glacial ice, giving an interest to this peculiar structure in the latter case, which it might not otherwise appear to possess for one who should regard it merely as a geologist.—*Athenæum*, No. 1614.

SUPPOSED ANTIQUITY OF THE HUMAN RACE.

MR. LEONARD HORNER has discerned the value of the phenomena of the annual sedimentary deposits of the Nile in Egypt as a test of the lapse of time during which that most recent and still operating geological dynamic had been in progress. In two Memoirs communicated to the Royal Society in 1855 and 1858, the results of ninety-five vertical borings through the alluvium thus formed are recorded. In the excavations near the colossus of Rameses II. at Memphis, there were 9 feet 4 inches of Nile sediment between 8 inches below the present surface of the ground and the lowest part of the platform on which the statue had stood. Supposing the platform to have been laid in the middle of the reign of that king, viz. 1361 B.C., such date added to A.D. 1854, gives 3215 years during which the above sediment was accumulated; or a mean rate of increase of 3½ inches in a century. Below the platform there were 32 feet of the total depth penetrated; but the lowest 2 feet consisted of sand, below which it is possible there may be no true Nile sediment in this locality, thus leaving 30 feet of the latter. If that amount has been deposited at the same rate of 3½ inches in a century, it gives for the lowest part deposited an age of 10,285 years before the middle of the reign of Rameses II., and 13,500 years before A.D. 1854. The Nile sediment at the lowest depth reached is very similar in composition to that of the present day. In the lowest part of the boring of the

sediment at the colossal statue in Memphis, at a depth of 39 feet from the surface of the ground, the instrument is reported to have brought up a piece of pottery. This, therefore, Mr. Horner infers to be a record of the existence of man 13,371 years before A.D. 1854 —"of man, moreover, in a state of civilization, so far, at least, as to be able to fashion clay into vessels, and to know how to harden them by the action of a strong heat."

EARLIEST SPECIMEN OF ANIMAL LIFE.

It had been supposed that the earliest specimen of a distinctly organized animal to be found in the rocks, was a trilobite, till, within the last year, a zoophyte of a very simple structure, named Oldhamia, was discovered at Bray Head, in Ireland, in rocks previously deemed destitute of fossils. We are reminded, however, by Colonel Portlock's address to the Geological Society, that specimens of the *Palæopyge Ramsayi* were found by Mr. Salter in the Cambrian rocks of the Longmynd, North Wales, which are quite as ancient as those of Bray Head. The trilobite is thus restored to its rank as the first created living being having a distinct and intelligible organization. Minute holes, *supposed* to be the burrows of sea-worms, were found along with the Palæopyge, but without anything to indicate their form or structure.—*Mr. Charles Maclaren, in the Scotsman.*

THE GLACIERS OF SWITZERLAND.—ASCENT OF MONTE ROSA.

The following letter "from a most earnest and philosophic investigator of the Glaciers," has been communicated by Professor Faraday to the *Times*:—

"August 23, 1858.

"My dear ———,—I now sit down to wipe away the reproach of having written a letter to you and not sent it. I reached this mountain wild the day before yesterday. Soon after my arrival it commenced snowing, and yesterday morning the mountains were all covered by a deep layer. It heaped itself up against the windows of this room, obscuring half the light. To-day the sun shines, and I hope he will soon banish the snow, for the snow is a great traitor on the glacier, and often covers smoothly chasms which it would not be at all comfortable to get into. I am here in a lonely house, the only traveller. If you cast your eye on a map of Switzerland you will find the valley of Saas not far from Visp. High up this valley, and three hours above Saas itself, is the Distil Alp, and on this Alp I now reside. Close beside the house, a many-armed mountain torrent rushes; and a little way down a huge glacier, coming down one of the side valleys, throws itself across the torrent, dams it up, and forms the so-called "Matmark see." Looking out of another window I have before me an immense stone, the unshipped cargo of a glacier, and weighing at least 1000 tons. It is the largest boulder I have ever seen, is composed of serpentine, and measures 216,000 cubic feet. Previous to coming here I spent ten days at the Riffel Hotel, above Zermatt, and explored almost the whole of that glorious glacier region. One morning the candle of my guide gleamed into my room at three o'clock, and he announced to me that the weather was good. I rose, and at four o'clock was on my way to the summit of Monte Rosa. My guide had never been there, but he had some general directions from a brother guide, and we hoped to be able to find our way to the top. We first reached the ridge above the Riffel, then dropped down upon the Görner glacier, crossed it, reached the base of the mountain, then up a boss of rock, over which the glacier of former days had flowed and left its marks behind. Then up a slope of ice to the base of a precipice of brown crags; round this we wormed till we found a place where we could *assail* it and get to the top. Then up the slopes and round the *huge bosses of the* mountain, avoiding the rifted portions, and going zigzag up the *steeper inclinations.* For some hours this was mere child's play to a mountaineer

—no more than an agreeable walk on a sunny morning round Kensington-gardens. But at length the mountain contracted her snowy shoulders to what Germans call a kamus—a comb; suggested, I should say, by the toothed edges which some mountain ridges exhibit, but now applied to any mountain edge, whether of rock or snow. Well, the mountain formed such an edge. On that side of the edge which turns towards the Lyskamm there was a very terrible precipice, leading straight down to the torn and fissured *névé* of the Monte Rosa glaciers. On the other side the slope was less steep, but exceedingly perilous-looking, and intersected here and there by precipices. Our way lay along the edge, and we faced it with steady caution and deliberation. The wind had so acted upon the snow as to fold it over, forming a kind of cornice, which overhung the first precipice to which I have alluded. Our attack for some time was upon this cornice. The incessant admonition of my guide was to fix my staff securely into the snow at each step, the necessity of which I had already learned. Once, however, while doing this, my staff went right through the cornice, and I could see through the hole that I had made into the terrible gulf below. The morning was clear when we started, and we saw the first sunbeams as they lit the pinnacles of Monte Rosa, and caused the surrounding snow summits to flush up. The mountain remained clear for some hours, but I now looked upwards and saw a dense mass of cloud stuck against the summit. She dashed it gallantly away, like a mountain queen; but her triumph was short. Dusky masses again assailed her, and she could not shake them off. They stretched down towards us; and now the ice valley beneath us commenced to seethe like a boiling cauldron, and to send up vapour masses to meet those descending from the summit. We were soon in the midst of them, and the darkness thickened; sometimes, as if by magic, the clouds partially cleared away, and through the thin pale residue the sunbeams penetrated, lighting up the glacier with a kind of supernatural glare. But these partial illuminations became rarer as we ascended. We finally reached the weathered rocks which form the crest of the mountain, and through these we now clambered up cliffs and down cliffs, walking erect along edges of granite with terrible depths at each side, squeezing ourselves through fissures, and thus by jumping, swinging, squeezing, and climbing, we reached the highest peak of Monte Rosa.

"Snow had commenced to fall before we reached the top, and it now thickened darkly. I boiled water, and found the temperature 184·92 deg. Fahrenheit. But the snow was wonderful snow. It was all flower: the most lovely that ever eye gazed upon. There, high up in the atmosphere, this symmetry of form manifested itself, and built up these exquisite blossoms of the frost. There was no deviation from the six-leaved type, but any number of variations. I should hardly have exchanged this dark snowfall for the best view the mountain could afford me. Still, our position was an anxious one. We could only see a few yards in advance of us, and we feared the loss of our track. We retreated, and found the comb more awkward to descend than to ascend. However, the fact of my being here to tell you all about it proves that we did our work successfully. And now I have a secret to tell you regarding Monte Rosa. I had no view during the above ascent, but precisely a week afterwards the weather was glorious beyond description. I had lent my guide to a party of gentlemen, so I strapped half a bottle of tea and a ham sandwich on my back, left my coat and neck-cloth behind me, and in my shirt-sleeves climbed to the top of Monte Rosa alone. When I see you I will tell you all about this ascent, which was a very instructive one. I expect to remain here a week. The house is cold, and at present the wet comes through the ceiling. I have caught a slight cold, which I hope will soon pass away, as I want all my vigour upon the ice. When I quit this place I shall make my way to Chamouni, where I expect to be in eight or nine days. With kindest, &c.,

"Most sincerely yours,

"JOHN TYNDALL."

"A Swiss Mountain-Climber" remarks upon this ascent:—

From my own knowledge of the difficulties of scaling Mont Blanc and Monte Rosa, the dangers of the latter exceed those of the former; but to reach the summit of Monte Rosa alone is a feat of daring and *strength* never heard of.

THE TERTIARY CLIMATE.

PROFESSOR UNGER, of Vienna, has found genuine reef forming corallidæ in the Tertiary strata of the Pannonian basin (south-east from Vienna), in latitude 47°, while at present the northern limit of such corals in the Red Sea and Persian Gulf is at 29°; thus furnishing a new proof of the higher temperature which prevailed in Europe at the Tertiary period.—*Mr. Chas. Maclaren, in the Scotsman.*

METAMORPHIC ACTION.

A PAPER has been read to the British Association by Mr. J. G. Marshall, "On the Geology of the Lake District," the object of the writer being to explain some of the geological phenomena of the Lake district, on the supposition of Metamorphic, instead of igneous, action.

Mr. Hopkins said they had heard sufficient on the subject of metamorphism to show that there was a difference of opinion on the question which had been raised, and it would be well to bear in mind that geology was a complex science—complex in its phenomena, and the causes to which those phenomena could be referred. That there had been a metamorphic action such as Mr. Marshall had pointed out was evident, but there were also phenomena which could not be referred to the same cause. There was one objection to this metamorphism for which Mr. Marshall contended—namely, the degree of heat it necessitated near the surface of the earth. There was an idea amongst some geologists that the earth's crust was really very thin. He was satisfied, from investigations he had made, that it was much thicker than some supposed, and much thicker than was consistent with that general metamorphic action suggested. Many of the rocks were of a fossiliferous character, and if animals existed upon the earth, the temperature must have been much lower than the hypothesis of a general metamorphic action contended for by some would warrant. There was no theoretical difficulty as to the metamorphic process in the older rocks spoken of; and he should be glad to accept the theory of Mr. Marshall so far as related to the older rocks, which he regarded as sedimentary; but when the theory came to be applied to more recent formations, they must exercise great caution before adopting it. As to the elevatory processes to which the Lake district had been subjected, he had before expressed the opinion that the last elevation was subsequent to the deposit of the mountain limestone, but the precise causes by which it was produced were yet undecided.

OLDER ROCKS OF THE SCOTTISH HIGHLANDS.

SIR RODERICK MURCHISON has read to the British Association, a paper "On the Results of recent Researches among the Older Rocks of the Scottish Highlands." The first part of the paper consisted of a confirmation of views which he had laid before the Geological Society, of the true Lower Silurian rocks being surmounted by *micaceous schists* and flagstones often passing into a younger gneiss. *The second part* of the communication related to the Old Red Sand-

stone, properly so defined, as exhibited on the east coast, between the Orkney and Shetland Islands on the north, and Banffshire and Morayshire on the south, various points of which the author visited last summer. In Caithness and the Orkney Islands, accompanied by Mr. Peach, the author made various interesting additions to his former knowledge, particularly as derived from the researches of Mr. Robert Dick, of Thurso. His belief was sustained that the ichthyolitic flagstones of Caithness and the Orkneys, with their numerous fossil fishes, constitute the *central* member of the Old Red series, the lower part of which is made up of powerful conglomerates and a very great thickness of thin-bedded red sandstone, the whole resting on the crystalline rocks; whilst the central flagstones are surmounted by other sandstones, rarely red, and usually of yellow colour, which occupy the promontories of Hoy Head, Dunnet Head, &c.

The chief additional data which had been gained by Sir Roderick during his last visit were owing to the discovery, by Mr. Martin, of Elgin, of a large bone in the very beds at Lossie Mouth, which had formerly afforded the huge scales of the supposed fish, called Stegonolepis, by Agassiz. On visiting these quarries with Mr. G. Gordon, he was so fortunate as to discover other portions of this large animal; so that comparative anatomists may now determine whether it belongs to fishes or reptiles. However this point may be decided, the existence of reptiles, during the formation of this deposit, is established beyond a doubt; since many slabs have been found in the coast quarries of Cummingstone and Covesea Hill, belonging to Mr. A. Young, in which are the footprints of both large and small animals, each footprint having the impression of three or four claws to it. A specimen, from Captain Brickenden, is in the Geological Society's Museum, and others have been sent to the Museum of Practical Geology, London; some of them having been contributed by Mr. P. Duff, of Elgin. The presence of large reptiles, as well as of the little Telerpeton, in this upper member of the Old Red Sandstone is therefore established. After noting certain fossil fishes which occur in parts of the Duke of Richmond's estates in Banffshire, the author proceeded to review the great masses of sedimentary deposit lying along the eastern and southern faces of the crystalline rocks of the Grampians, which have been hitherto all classed as pertaining to the Old Red Sandstone, though he does not pretend as yet to be competent to describe their detailed relations. On these points, however, which Mr. D. Page is working out with ability, he begs to offer the following suggestion. The true base of the Old Red Sandstone, properly so called, is seen in Shropshire and Herefordshire to be a red rock, containing Cephalaspis and Pteraspis, which gradually passes down into the grey Ludlow rock; and in both of these contiguous and united strata, remains of large Pterygoti, but of different species in the two bands, are found. Now, although the Arbroath *paving-stone*, and the grey rocks ranging to the north of Dundee, much resemble the uppermost Ludlow rock, they contain the *Cephalaspis Lyellii*, and if, therefore, classed with the Devonian rocks, they must, under every circumstance, be viewed as the very base of

that natural group. It follows, therefore, that certain conglomerates on the flanks of the Grampians, which underlie all those grey rocks with Pterygoti and Cephalaspis, can no longer be united as they have been with the Old Red or Devonian, but must represent some portion of the Silurian system. In speaking of the lowest member of the Old Red Sandstone, as characterized by the *Cephalaspis Lyellii*, the author expressed his conviction, that in the north-eastern Highlands and Caithness the zone is represented by the vast thickness of thin-bedded red sandstone and conglomerates, which had been already adverted to as lying beneath the Caithness flags. The author, who had recently visited Dura Den, in Fifeshire, in the company of Lord Kinnaird and the Rev. Dr. J. Anderson, whose work on that beautiful tract is well known to geologists, declared that there could be no doubt whatever that the yellow sandstones of Fife pertain truly to the Old Red group, are entirely subjacent to the lowest carboniferous sandstones, and are of the same age as the upper yellow sandstones of Elgin. A drawing, prepared by Lady Kinnaird (the splendid specimen being in the museum at Rossie Priory), of the fossil fish *Holoptychius nobilissimus*, nearly three feet in length, which was found on the occasion of this visit on the property of Mrs. Dalgleish, was exhibited; and as this species abounds in the lower and red portions of the deposit, and also occurs in the overlying yellow sandstones, associated with *Holoptychius Andersoni* and *H. Flemingii* of the latter, the age of the deposit is clearly substantiated. In conclusion, Sir Roderick said that this communication must only be considered as a rehearsal of what was to be done with more effect next year at Aberdeen, when further observations might lead him either to confirm or modify some portion of his views. In the mean time, the great fundamental reform of the North Scottish series, proving the ascent from rocks on the west coast, which are unquestionably older than any in England and Wales, to the much younger "Old Red Sandstone" of the east coast, is firmly established. The communication was illustrated by several geological maps, including an old one coloured by himself thirty-one years ago, the maps of M'Culloch, Nicol, and Knipe, and a map of Sutherland which the author coloured this summer. Besides large diagrams, there were sketches of the west coast of Sutherland by Miss C. Dempster.—*Athenæum*, No. 1617.

THE COAL MEASURES.

We have received from Mr. H. Landrin a very elaborate paper, entitled "Considérations Philosophiques sur l'Ordre de Superposition des Combustibles dans la Nature." He has treated his subject with much ingenuity, and given ample evidence that he is thorough master of it. He remarks that millions of ages elapsed between the period when the earth was in a state of incandescence and its *refroidissement séculaire*, and we may conceive all possible reactions in the several states through which our sphere has passed. One remarkable period was *that in* which solidification first commenced, in which the *earth was moist with* hot water, and an atmosphere saturated with *steam and carbonic* acid. When the temperature fell to 60° C., the

vegetable elements commenced to develope themselves, and this went on until the temperature was reduced to 40° C.; then a considerable absorption of carbonic acid in the midst of aqueous vapour, suitable for facilitating the operation of affinity. Animals with respiratory organs could not exist in this atmosphere, where, however, plants vegetated easily, or even luxuriantly. These were, therefore, the first born, which is as it should be, since animals cannot live without plants, although plants could exist without animals.—*Mining Journal.*

DISCOVERY OF COAL IN AUCKLAND.

THE New Zealand papers contain particulars of the discovery of valuable Coalfields, within eighteen miles south-east of the city of Auckland, in the Opaheke and Hunna districts. On the discovery being made, a committee was appointed to carry out the explorations, which resulted in the opening on the land of one gentleman of a seam of coal seven feet in thickness, bearing every indication of its extending a considerable distance, and on another portion of land the results were beyond the most sanguine expectations. The coalfields are so situated as to permit of the transit of the coal to various parts of the colony, at an exceedingly small cost. A trial of the qualities of the coal thus discovered is announced as having taken place in the *White Swan* steam-ship, and the engineer of the vessel in his certificate states it was perfectly satisfactory, that he has no hesitation in saying that the coal is of a superior quality, and he should feel perfectly satisfied with it for a sea voyage. These discoveries are hailed by the colonists with the greatest satisfaction, and it is supposed that a large amount of capital will be kept in the province which is now annually sent away for imported coal—that steam communication will be promoted, and that the event will be likely to prove the forerunner of other sources of wealth to the provinces, as iron and copper may be smelted in close proximity to the coal beds.

GOLD IN BRITISH COLUMBIA.

GOLD has been discovered in great abundance on the Frazer and Thompson Rivers, in British Columbia, the territory on the mainland in the vicinity of Vancouver's Island. At the junction of the two rivers, and in the immediate vicinity, lie the diggings, which have been worked more or less since the summer of 1857, but their real importance was not ascertained until lately. At Hill's Bar, one of the richest spots on the river, the produce had risen as high as 13*l.* per man per day. The whole distance from the mouth of Frazer's River to the gold diggings at Thompson's River is 160 miles or thereabouts.

GOLD IN GUIANA.

A CORRESPONDENT of the *New York Tribune*, who dates his letter from Ciudad Bolivar, August the 20th, says—"Since my last I have visited the Gold Mines of Guiana, the veritable El Dorado, so fruitlessly sought for by Sir Walter Raleigh. The mines were dis-

covered about two years since by an Indian while hunting in the woods for stray donkeys. He pulled up a bush and found a large piece of pure gold at the roots. He carried it to a German merchant at Tapequeen (six miles distant) for sale, and the trader endeavoured to obtain the secret of its discovery from the Indian. He refused to give the required information, and he was made drunk, and then cruelly beaten until the secret was finally wrung from him. The discovery of these mines corresponds with the description given by Sir Walter Raleigh of the manner in which the Indians obtained their gold—viz., 'And being asked how they got the same gold, they told us they went to a certain down or plain, and pulled or digged up the grass by the root, which done, they took off the earth, putting it in great buckets, which they carried to wash at the river.' That these mines were known to the early Spaniards is proved by the recent discovery of certain letters found in a trunk in the abandoned cathedral at Guasipate, fifteen miles distant from Caratel. The mines are undoubtedly exceedingly rich, and large quantities of gold have already been discovered. In consequence, however, of the labour required to obtain it, and the deadly nature of the climate, they will not repay individual enterprise. Companies well organized, and with the requisite machinery to work the gold quartz, and drain the pools at the base of the various cascades, will undoubtedly realize vast fortunes. During my stay of four weeks at the mines, there were only about sixty miners engaged in working, and over $2500 in gold was found. One piece weighed four pounds and a-half. The quartz is exceedingly rich, and a charter has been given to a company, composed mostly of citizens from New York, conferring upon them the exclusive privilege for six years of working the quartz in Caratel and Tapequeen."

THE GOLD FIELDS OF VICTORIA.

MR. A. R. C. SELWYN, Geologist to the Colony of Victoria, has communicated to the Geological Society a paper, in which he states that in the Colony of Victoria, from a line east of Melbourne to some distance west of that place, he has traced a succession of fossiliferous palæozoic rocks, commencing with schists, much cleaved and contorted, and containing *Lingulæ* and *Graptolites*, passing through a series of schists and sandstones with *Trilobites* and many other fossils characteristic of the lower, middle, and upper Silurian Series of Britain, and terminating with Devonian and Carboniferous rocks; and he remarks that the younger or Oolitic (?) coal-bearing beds on the west rest unconformably on the palæozoic rocks. A list of about sixty genera of Silurian fossils, including many new species, was appended.

The gold-bearing quartz-veins of the Silurian rocks appear to the author to be dependent more on their proximity to some granitic or other plutonic mass than on the age of the rocks in which they occur. Quartz-veins do not appear to traverse the Oolitic (?) coal-rocks, which are of newer date than the granites of this district.

The author's observations refer chiefly to Bendigo, Ballarat, and

Steiglitz gold-fields, where *Graptolites* and *Lingulæ* occur in the schists, which are traversed by the gold-quartz veins. The granites here do not contain gold; and, though they have altered the slate-rocks at the line of junction, yet they do not appear to have affected their general strike or dip, but appear to have themselves partaken of the movements which have placed these Silurian rocks in their present highly inclined and contorted positions, and given them their very uniform meridional direction.

Mr. Selwyn recognises gold-bearing drifts of three different ages. The lowest contains large quantities of wood, seed-vessels, &c., at various depths, to 280 feet, and is associated with clays, sands, and pebbles. These are overlaid by sheets of lava. A more recent auriferous drift, containing also bones of both extinct and living marsupial quadrupeds, overlies these lavas in some places; in others, it rests on the older drifts; and at Tower Hill, near Warnambool, marine or estuary beds of probably the same age are overlaid by volcanic ashes. A third and still more recent gold-drift is found on the surface, overlying indifferently any of the older deposits.

The gold is found at the base of these drifts or gravels, which are the result of the immediate waste, by atmospheric and fluviatile action, of older masses, and have not been far transported. The largest amount of gold is found in the drifts when near the Silurian schists. The author believes that there is every probability of gold-deposits existing under the greater portion of the lava-plains of the region to the westward.

Mr. Selwyn also describes a cave which he has discovered in the basaltic lava of Mount Macedon, a few miles north of Melbourne, and in which he has found bones of many living species of mammals, including the "devil" of Tasmania, and the Dingo or native dog. The cave is about 1000 feet above the sea-level, and 30 miles inland.

Mr. John Phillips, Government Surveyor, has also communicated some Notes on the Ballarat Gold-fields, which he concludes by observing:—

In the basin of the Yarrowee, which is covered chiefly with gravel, the author traces the run of the "gold-leads" or old gullies, which have only an approximative resemblance to the ramifications of the present river. These ancient gullies or leads had a very uniform fall, which, from the smallness of the contents of the gullies, must have been as rapid as 16 in 1000, while the fall of the present Yarrowee has only a fall of 8 in 1000.

Mr. Phillips urges that all the basin between the gold-leads may be wrought by the aid of the water-power of the Yarrowee; a thousand horse-power being now allowed to run waste, which, by means of reservoirs, could be made available.

The author adds that silver-nuggets have been reported on good authority to have been found within thirty miles of Ballarat. He further observes, that, whilst surveying the district, oscillations of the spirit-bubble indicated a rocking of the earth; and that the

country in places sounds hollow, like a wooden bridge, horses even noticing it in passing.

Mr. W. Redaway has also communicated "Notes on the Gold-diggings at Creswick Creek and Ballarat."

GIGANTIC AUSTRALIAN LIZARD.

PROFESSOR R. OWEN has communicated to the Royal Society the description of some remains of a gigantic Land Lizard from Australia. A collection of fossil remains now in the British Museum demonstrates the former existence in Australia of a land lizard far surpassing in bulk the largest species now known. The characters are derived from vertebræ, partially fossilized, equalling in size the largest known crocodiles. They are of the procœlian type, presenting lacertian modifications, and agreeing closely with those of the existing lace lizard of Australia. A generic distinction is indicated by the comparatively contracted area of the neural canal, and by the inferior development of the neural spine of this fossil vertebra, which, from the proportions of the body, must have belonged to an animal not less than 20 feet in length. For this probably extinct lizard the name of *Megalanea prisca* is proposed.

RARE AUSTRALIAN FOSSIL.

PROF. OWEN has communicated to the Geological Society, "Notes on some Outline-drawings and Photographs of the Skull of *Zygomaturus trilobus*, Macleay, from Australia," received by him from Sir R. Murchison, being seven photographs, three of which are stereoscopic, of perhaps the most extraordinary Mammalian fossil yet discovered in Australia.

These photographs were accompanied by a brief printed notice of their subject, by William Sharp Macleay, Esq., F.L.S., and some MS. notes by J. D. Macdonald, M.D., R.N. Professor Owen had some weeks previously received from George Bennett, Esq., F.L.S., of Sydney, outlines of the same fossil skull, made by him on the reception of the specimen by the authorities of the Australian Museum at that town; and the Professor had penned notes of his comparisons of these sketches before receiving the photographs and descriptions of the fossil skull from Sir R. I. Murchison.

This unique and extraordinary skull of a probably extinct Mammal, together with other bones, but without its lower jaw, were found at King's Creek, Darling Downs,—the same locality whence the entire skull and other remains of the *Diprotodon* have been obtained.

Mr. Macleay has described the fossil under notice as belonging to a marsupial animal, probably as large as an Ox, bearing a near approach to, but differing generically from, *Diprotodon*. He has named it *Zygomaturus trilobus*. The skull has transversely ridged molars, and a long process descending from the zygomatic arch, as in the *Megatherium* and *Diprotodon*, and exhibits an extraordinary width of the zygomatic arches. The skull at its broadest part,

across the zygomata, is 15 inches wide, and is 18 inches long. In *Diprotodon* the skull is about 3 feet long by 1 foot 8 inches broad: so that while the latter must have had a face somewhat like that of the Kangaroo, the *Zygomaturus* more resembled the Wombat in the face and head.

Wholly concurring in Mr. Macleay's conclusions as to the marsupial nature of the fossil in question, Professor Owen does not think that it exhibits evidences of a generic distinction from *Diprotodon*. The Professor suggested, however, that probably the lower jaw, when found, may show some peculiarities of dentition and proportions similar to those on which he has founded the genus *Nototherium*.

SIGMARIA AND SIGILLARIA.

At the Manchester Geological Society, Mr. Binney has read a paper, the object of which was to show that the Sigmaria, instead of being, as commonly supposed, a distinct plant, was the root of the Sigillaria found in coal and coal floors. The roots sometimes ran along for a distance of thirty feet, striking into the floor of the coal bed, and the rootlets were six or seven or even ten feet long. It must have been a quick-growing plant.

BONE CAVERN NEAR TORQUAY.

There has been read to the British Association a paper "On a recently-discovered Ossiferous Cavern at Brixham, near Torquay," by Mr. W. Pengelly. He described the structure and formation of the cavern, and the means taken for its excavation and exploration, remarking that upwards of 2000 bones of animals had been found in it, amongst which were mingled flint knives and heads, evidently made by man.

Professor Ramsay read a Report from the local committee at Brixham, from which it appeared that Dr. Falkner had found amongst other ossiferous remains the bones of the rhinoceros, bos, horse, reindeer, cave bear, and hyæna, and also several well-marked specimens of flint knives, generally accepted as of Celtic manufacture.

Professor Owen said he was glad that means had been taken for the careful exploration of this cave, but it would be premature to raise any hypothesis until the whole of the facts were before them. He had not yet seen any of the bones, and indeed was entirely indebted for what he knew on the subject to the paper which Mr. Pengelly had read, and he should refrain, therefore, from expressing any opinion, but he wished to caution them against coming to conclusions as to the antiquity of these remains which were not really warranted. He proceeded to show, from the remains of tigers, elephants, and other animals found in this country, in Siberia, and other parts of the world, where the climate was much colder than was supposed to be compatible with their existence, that there was undoubted evidence that these animals could adapt themselves to cold and temperate climates as well as to torrid ones, and remarked that the conditions of animal life were not those of climate, but of

food and quiet. Wherever there was the prey, undisturbed by man, there also would be the destroyer. They had evidence from the writings of Julius Cæsar of the existence in England, 2000 years ago, of three distinct species of animals, including two gigantic species of ox, and one of the reindeer, and he was himself satisfied that they had once had a native British lion, all of which, however, were now extinct in this country, and he saw nothing in the remains which had been discovered at Brixham to lead him to suppose that the animals lived before the historic period, or which was inconsistent with the concurrent existence of a rude race of barbarians. At the same time he was open to conviction, and should be very glad to see a good fossil human being, which should prove that man had been much longer upon the earth than historical evidence led them to suppose.—*Athenæum*, No. 1615.

YORKSHIRE FOSSILS.

At the late Meeting of the British Association, Mr. Charlesworth, after making some general observations upon the extreme difficulty of arriving at any satisfactory conclusion with respect to the determination of species as distinct from varieties, said that the beautiful fossil sponges found in the chalk near Flambro' Head presented an almost endless diversity of form; and although Professor Phillips and other geologists had classed these forms as entitled to specific distinction, he (Mr. Charlesworth) had long since come to the conclusion, that nearly the whole of them might be referred to one species. In illustration of this view, specimens were exhibited to the Section, in which what have been regarded as widely differing species were given off from the same stalk. This communication was illustrated by a series of most beautiful fossil sponges from the cabinet of Miss Walker, of Sand-Hutton, near York.

VOLCANIC EMANATIONS.

The deficiency of our information regarding the Gaseous Products of Volcanoes seems to have induced the Academy of Sciences to send two of their men of science, Messrs. St. Clair Deville and Leblanc, to Italy, on a special mission to examine the gases which issue from the volcanoes of that country. They were supplied with peculiar apparatus, made for the purpose of collecting and preserving the gases, and partly for examining them on the spot. The memoir containing the result of their investigations has been made the subject of a Report by three very accomplished members of the Academy—Messrs. Dumas, Boussingault, and Elie de Beaumont. They state that M. Deville and his associate were enabled by their apparatus to collect gases over mercury not only at the orifice of the volcano, but *at great depths in the vent*; in the latter case by slender tubes, which were rapidly closed by the blow-pipe. The gases they brought away and analysed in Paris were from Vesuvius, the Phlegrean Fields, one of the Lipari Isles (Vulcano), and Etna. *Mixed with the gaseous products they found much heated air, more or less* altered by the addition of gas or vapours, or the

absorption of oxygen, which led them to believe that common air penetrates into the vent of the volcano by a fissure, is exhaled by it, and escapes heated. Generally, the Report confirms the opinions of Davy as to Vesuvius, Boussingault as to the Andes, and Bunsen as to Iceland, but with some additions. They show that different fumeroles of one volcano do not yield the same gas, and that the gas from a single fumerole is not always the same. Further, the gas from the different fumeroles varies with their distance from the eruptive crater, and varies also with the time elapsed from the commencement of the preceding eruption. The Report concludes by expressing an opinion that the gaseous emanations, carefully analysed and compared, will throw light on the chemical processes which gave them birth, and enable observers in the vicinity of a volcano, and through them the surrounding population, *to foresee the course which a coming eruption is likely to run*, and of course serve as a useful warning.

VESUVIUS IN ERUPTION.

A LETTER from M. de Verneuil, the geologist, dated Jan. 6, 1858, states that it was then sending forth streams of vapour from two mouths—the one in the centre of the plateau or flattened top of the mountain, the other at the foot of a little cone situated on the east side. The first fumerole is a cavity, and about 164 feet in diameter, and surrounded by three little conical eminences, and the vapour issues from an opening of apparently about 26 feet in diameter. The stream of vapour is continuous, but mingled with violent jets, which are accompanied with discharges of fragments. Looking down from the edge of the cavity, when a violent explosion takes place, red vapours are seen which might be mistaken for waving flames. In 1856, the centre of the plateau was occupied by a circular cavity, 51 feet in depth, from which there were small eruptions at short intervals. This has been filled up and replaced by the small cavity and little cones above mentioned. But another change has taken place which has materially altered the outline of the hill. The eminence at the north side of the plateau, called the *Punta de Palo*, which has towered over the rest of the plateau, we believe, for half a century, has disappeared, and the general level is now broken only by the three salient conical eminences, each about fifty feet in height. The breadth of the plateau has not varied much for many years. When the writer of this note visited the hill in 1839, and again in 1847, it was about 2000 feet.—*Mr. Charles Maclaren, in the Scotsman.*

M. ST. CLAIR DEVILLE has read to the French Academy of Sciences a letter from M. de Verneuil, who wrote from Naples to state that Mount Vesuvius was on Jan. 6th emitting torrents of vapour from two mouths—one in the centre of the plateau, and the other at the foot of a little cone lying to the east. The former was stated to be an abyss 50 inches in diameter, crowned with three conical eminences, and terminating in an orifice about eight metres in diameter, whence the smoke issued continuously, though at times

larger volumes were emitted by puffs, accompanied with fragments of rocks. When such puffs occurred, the bottom of the abyss was filled with red vapours, which an ordinary spectator would mistake for flames. The writer adds that about three weeks before the above date, three streams of lava had descended into the Atrio del Cavallo, and that the Punta del Palo was no longer distinguishable from the rest of the plateau.

SEISOGRAPHIC MAP OF THE WORLD.

A VERY interesting Map has been published with this title, in which, on Mercator's projection, are laid down careful indications of the regions subject to earthquakes and the sites of volcanoes. In the language of its constructor, it shows "the surface distribution and space of earthquakes," and is intended to illustrate a paper contributed by Mr. Robert Mallet, F.R.S., &c., of Dublin, and his son, Dr. J. W. Mallet, to the late meeting of the British Association at Leeds. As a very large number of copies of the Map is required, and the greatest accuracy of delineation is necessary, it has been executed in chromo-lithography by Mr. George Falkner, of Manchester, and printed in a series of different tints from eight different stones. Thus, various shades of orange and orange red show what are termed the "seismic bands" in their position and relative intensity. Small black discs denote "volcanoes, fumeroles, solfataras," now active, or presumed to have been so within historic or recent geologic periods. A speckled gray blue shade indicates the areas of subsidence (whether suboceanic or terranean) now proceeding. A green line demarcates land from sea. Of the great oceans, only the Atlantic shows much of that agency which produces earthquakes, and that chiefly in its latitudes north of the equator. The Pacific has almost an immunity from these throes of earth's inner crust. Of the continents, Europe has the fainter tints of "seismic bands" in the north; but only in Iceland does the deeper hue indicate great intensity, accompanied by the signs of considerable volcanic action, there being ten smaller dots, besides the large one for Hecla. The Azores, Teneriffe, and Cape Verd Islands, are all shown to be volcanic; and along the south of Europe the band is of greater intensity, and especially in Italy, also marked as volcanic. There is a deep band from the Levant and Cairo to Tiflis, and it meanders across Persia and Central India to Calcutta. A large tract of sea and land encircling Borneo is clearly one of the most intensely seismic and volcanic regions of the earth. The bands then extend in a north-easterly direction, over Hongkong, Jeddo, &c., and across the ocean to the Russian and British territories on the north-west coast of North America. The band extends along the whole of the western coast of Labrador, California, &c., increasing in intensity as it enters Mexico, and here again volcanoes become prevalent. This continues over Central America, and again pursues the line of the west coast of South America to Cape Horn. In the West Indies is another line or band, and the coast of the United States has a band *of less intensity*; while the only approach to the centre of the North

American continent is along the valley of the Mississippi. The most northerly portions of Europe, Asia, and North America, are quite free from these influences. But from the West Indies a band extends southward (with a branch touching the south-east coast of Australia), through New Zealand, to nearly 80° south latitude; terminating in the volcanic peak of Mount Erebus. It is remarkable that the ocean which receives the electric cable should be so intensely "seismic," while the Pacific is diametrically opposite in condition.—*Manchester Guardian.*

EARTHQUAKES IN SOUTHERN ITALY.

DR. LACAITA, in a paper read to the Royal Institution, has described the six great Earthquakes, without counting minor shocks, which have, within the memory of man, laid waste extensive tracts of the kingdom of Naples, and caused great loss of life; and especially of the last earthquake, which took place on the night of the 16th of December, 1857.

1. On the 5th of February, 1783, the Piana di Monteleone, in the province of Calabria Ultra I., was convulsed. In less than two minutes 109 villages and towns were levelled with the ground, and 32,000 persons were buried out of a population of 166,000. A repetition of the shock ruined the towns of Reggio and Messina. At the Faro Straits the sea, first retiring, then rushing back, swept away 1500 persons. In March following, an area of 1200 square miles, from Reggio to Cape Colonna, was shaken, and 2000 more inhabitants were victims. The physical aspect of the country was entirely changed; a pestilential fog set over it; epidemic fevers followed; and by the end of the year Calabria had lost 80,000 inhabitants, having received during this time 949 shocks.

2. On the 29th of July, 1804, the mountain of Frosolone, in the province of Molise, was the centre of a violent shock which lasted 35 seconds, producing desolation over an area of 600 square miles; 61 towns and villages were ruined, and more than 6000 persons were crushed to death.

3. On the 29th of April, 1835, violent shocks were felt at Calabria Citra, which caused the death of more than 1000 persons.

4. On the 12th of October, 1836, another violent shock was felt in the same province, which swept away more than 600 inhabitants.

5. On the 12th of August, 1851, the city of Melfi, an extinct volcano in the province of Basilacata, was the focus of a violent earthquake. The first shock lasted twenty seconds, the second only five seconds, yet 1400 lives were sacrificed.

6. But worse than any of the later earthquakes, and second only to the Calabrian one of 1783, was the earthquake which took place on the 16th December, 1857, at 10¼ P.M., when a sharp undulatory shock of twenty seconds' duration, immediately preceded and accompanied by an appalling hollow rumbling noise, after a hardly perceptible pause of about three minutes, was followed by a second and most violent successive and whirling shock of twenty-five seconds' duration, which crushed thousands of the inhabitants under the ruins of their falling houses. Three other shocks were felt on that awful night, and many others on the following days, but none nearly so violent and destructive as the two former ones. For nearly two months a slight shock was felt almost periodically just before sunrise.*

On the 7th of March, 1858, about 3 P.M., a violent shock, second only to those of the 16th of December, was felt, which caused considerable injury; and, up to the 28th of April last, the shocks, though comparatively slight and harmless, still continued. On the whole, by this terrific earthquake, at least 22,000 human beings, on a most moderate calculation, were destroyed in a few seconds.

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* For the details of this Earthquake to Jan. 4, see *Year-Book of Facts*, 1858, pp. 271-273. M. Quetelet, jun., states that on the 16th of December the magnetic needles in the Observatory at Brussels were violently agitated, and draws attention to the fact that it was on that day that the earthquakes at Naples were first felt.

From the data in this paper it will be seen that in the course of seventy-five years, from 1783 to 1857, the kingdom of Naples lost at least 111,000 inhabitants by the effects of earthquakes, or more than 1500 per year, out of an average population of 6,000,000!

EARTHQUAKE IN LISBON.

SOME smart shocks were felt on the morning of the 11th of November, 1858, in the neighbourhood of Lisbon, sufficient to cause alarm, but fortunately attended with scarcely any loss of life. The meteorological warnings of the internal commotion were two days of incessant heavy rains with heavy atmosphere, the wind being rather fresh from E.S.E.; during the day the wind changed, and a sharp gale was experienced. The first shock lasted fully half a minute, and shook every house in Lisbon; it is the most violent that has occurred since the great earthquake of 1755. The houses are all built on a mixed system with a framework of wood, which renders them more elastic; chimneys were hurled down, walls were cracked and thrown down, but no building was destroyed. At a small town about twenty-five miles from Lisbon, on the Tagus, a number of houses were hurled down, and several deaths had in consequence occurred.

EARTHQUAKE IN MEXICO.

ON the 19th of June, 1858, occurred one of the most severe Earthquakes known since the Spanish invasion. At nine o'clock in the morning, a shock came from the south. This was followed by three more violent shocks from the same direction; then four more shocks, equally severe, from the east, and after them a few tremblings. In the city of Mexico, the strongest structures reeled to their foundations; the water spouted in jets from the sewers; the street lamps vibrated from east to west for a quarter of a minute. The earth opened in the streets; trees writhed and swayed for many minutes, and some were thrown out of the earth. Houses, aqueducts, and railroads were seriously injured. About twenty-four towns and cities in Mexico sustained damage from the earthquake, and a vast number of lives were lost. All the violent shocks took place in the space of about one minute and a half. The shocks and tremblings lasted about three minutes.

EARTHQUAKE IN DORSETSHIRE.

THERE has been read to the Geological Society, a "Notice of the Occurrence of an Earthquake along the Northern Edge of the Granite of the Dartmoor District, on September 28, 1858," by Mr. G. Wareing Ormerod, F.G.S. The shock was slight, and appears to have been confined to a very narrow district, that may be estimated as not exceeding 8 miles in width, and running along the northerly edge of Dartmoor, along the line of junction of the granite and the altered carbonaceous rocks. The shock seems to have taken a direction from east to west, to have occurred about 8 o'clock in the evening, and to have lasted, where most severe, about 15 seconds.

Astronomical and Meteorological Phenomena.

GREAT SOLAR ECLIPSE.

THE nearly total Eclipse of the Sun, such as will, we believe, not again occur in England during the remainder of the present century, took place on Monday, March 15, 1858.

The eclipse, though central, was only annular (the moon being in the farthest part of the elliptical orbit, and the sun and earth in the nearer part of theirs), and was visible even in this way—*i.e.*, a way by no means sufficient to produce total obscuration and the darkness of night—to but a narrow strip of country extending diagonally across England, from the Start Point on the southern, to the Wash on the eastern coast. Only a few miles on either side of that line the eclipse was but a partial one—*i.e.*, a crescent of the sun was left untouched at the instant of greatest obscuration, broader and broader in proportion to the transverse distance from the annular line.

The weather was unfavourable for observation. Had it been such as to have permitted the moon's passage to be closely observed, Swindon was the best place for seeing it; but at Blisworth, near Northampton, the obscuration of the sun's disc was equally great—999 magnitudes out of the 1000 being eclipsed there also. With the exception of these two places, however, at no other town in the United Kingdom was the eclipse more total than at London; and only at Peterborough, Dartmouth, Buckingham, and Axminster was it as great. London, however, did not come within the line of annular eclipse, which entered England close to Lyme Regis, passing by Yeovil, Frome, Westbury, Swindon, Woodstock, Towcester, and so on by Northampton, Wellingborough, Oundle, and out at the Wash.

We have only space for the following details condensed from a few of the accounts of many observers:

In the Report of the Astronomer Royal it is stated, with regard to general phenomena at Greenwich, by Mr. Dunkin: "At the exact instant of contact the sun was obscured; in less than a minute he again appeared, and the moon had then advanced considerably on the disc, the limb looking clearly defined, and without any irregularities; clouds immediately covered the sun, and from this time, excepting only a few occasional glimpses, nothing more was seen till after the greatest obscuration." Mr. E. J. Hallam's remarks were, that the sun was first eclipsed at 0h. 2m. 52s.; it was afterwards occasionally seen through the clouds till 0h. 37m., when rather more than half of it was covered; it was not seen again till 1h. 1m. During the eclipse there appeared a great deal of fog and mist about the ground, which gradually disappeared as it advanced. When the sun was nearly totally eclipsed, the sky had the appearance of an approaching storm. When the eclipse commenced, the wind

became very calm. Previously it had been blowing a heavy gale from the west and north-west. At 1h. 50m. a few drops of rain fell, and occasionally fell afterwards till 2h. 15m. At Bedford, Mr. Riddle stated "that clouds began to gather a little before 10 o'clock, and at the time of first contact the sun was quite invisible. Soon after this there was a momentary glimpse of the sun, showing the moon considerably advanced upon the disc; and at intervals a few similar glimpses occurred, which enabled him and the lads assisting him to take on the whole sixteen measures of the distance of the cusps." At Great Harrowden, the Astronomer Royal states that the sun was only visible for a few instants. "The only phenomena observable were those relating to the darkness produced by the eclipse. The closing in of the clouds and the dull uniform leaden hue which they exhibited, the rapid increase of darkness near the time of greatest obscuration, and the apparent pulsations by which it was accompanied; the still more startling phenomenon of the instantaneous return of a great portion of the light on the breaking up of the annulus—were observed, and of themselves amply repaid those present for the trouble which had been taken. The effect on the rooks, which before the eclipse had gone into the neighbouring fields to feed, was very remarkable. For several minutes before the time of greatest obscuration they returned to the rookery in groups, and after considerable clamour of cawing were seen to return into their nests; but on the light reappearing they came out in a body, and flew off clamorously into the field again."

Mr. John Yeates, F.R.G.S., writes from Fotheringhay Castle-mound, Northamptonshire:—"There was nothing like intense darkness during the eclipse; I have seen more gloom in a thunder-storm. Bystanders prognosticated rain; but it was the shadow of a rapidly declining day. At twelve o'clock a lady living on the farm suddenly exclaimed, 'The cows are coming home to be milked!' and they came, all but one; that followed, however, within the hour. Cocks crowed, birds flew low or fluttered about uneasily, but every object far and near was well defined to the eye. A singular broadway of light stretched north and south for upwards of a quarter of an hour; from about 12.54 to 1.10 P.M." All the phenomena of an annular eclipse, however, were visible at this locality, and Baily's beads were perfectly plain on the completion of the *annulus*. These "beads" are described by Mr. Yeates as appearing "on the upper and under sides of the moon, and occupying fully three-fourths of her circumference."

From Peterborough, Mr. W. L. Wharton writes: "I noticed, shortly before one o'clock, and in the midst of the very remarkable gloom which prevailed at the time, some slight openings in the clouds, through one of which the sun was very distinctly visible for some fifteen or twenty seconds. Being furnished with an excellent little telescope (magnifying about 15), and able to rest it firm against a pier of the station, I saw through it Baily's beads, I should imagine, to the utmost perfection, the thin passing cloud rendering any

coloured eye-glass unnecessary. I am unable to describe their beauty, projecting to the number of some six or eight from each cusp of the sun, and resembling little irregular and constantly increasing and decreasing globules of bright quicksilver. The sky, after the above interval, became obscured for about a minute, when another break in the clouds exhibited for some five to ten seconds *the perfect annulus* to the naked eyes of some two or three hundred spectators around me, and who, as it were, by one common impulse, greeted the phenomenon with a cheer of delight. On looking at the annulus through my telescope, I found the beads had vanished, being replaced by a well-defined continuous ring of light. The sky became again obscured, and I saw no more of the eclipse."

An intelligent observer in Essex writes to the *Literary Gazette* as follows: "The sun could no longer be called a crescent; it was reduced to something so thin as to look like a half-ring of fine silver wire, whose central portion must have been less than half a minute in diameter. We looked earnestly and anxiously for some indication of difference of curvature in one or other body; suddenly a pulsation began in the region of bright mist in front of the sun. The actual clouds were driving along from the west; but were at this time all of them so thin that the region about the sun and moon for a diameter of about a degree and a half was always suffused with light, and in this region it was that the luminous pulsations commenced.

"A visible motion of the solar cusps began: it went on, increasing rapidly; they moved more like a steering-wheel under the hand of a stout seaman than any celestial phenomenon. Every one immediately perceived the shifting line of cusps; a hundred degrees of angle were passed over in a few seconds, and presently the solar crescent was nearly on the opposite side to where it had been during all the earlier portion of the eclipse.

"The rapidity of this change of angle in the cusps—a necessary consequence of the very near approach of the moon's centre to that of the sun—might have been computed beforehand, of course; but for all that, the actual witnessing of it for the first time in one's life, when that life has been spent in labouring to measure and appreciate those minute and slow changes among celestial bodies, which are generally all that present themselves to an astronomer after the ordinary phenomena of diurnal motion, is something to leave an impression for the period of one's natural life."

Mr. James Glaisher, F.R.S., writes from Oundle:—"By tables and diagrams it is shown that the depression of temperature during the eclipse was about 2½° at those stations north of the line, and nearly 3° at stations on and south of the line of central eclipse; that at places where the usual diurnal increase had taken place in the morning, the depression of temperature during the eclipse was *greater*, and that at places where such increase had not taken place it was *less* than the above numbers; also, that at places where the sky was uniformly cloudy during the day, the decrease in the readings of a blackened-bulb thermometer was less than 12°, whilst at places

where the sky was partially clear, the depression was from 17° to 19°, and that what temperature soever the blackened-bulb thermometer indicated in the morning, fell during the eclipse to that of the temperature of the air at all places. The humidity of the air was such that at places north of the line the wet-bulb thermometer read 2°·6′ less; on and near the line the depression 3° 21′; and south of it was 3° 7′ below the adjacent dry-bulb thermometer. The complete ring was seen at Charmouth and its neighbourhood, near Lyme Regis, and at Peterborough, but, so far as I can learn, at no other places. My own station was on the calculated line of central eclipse, near Oundle, in Northamptonshire, and here I saw the moon's and the sun's apparent upper limbs coincident, or very nearly so, and therefore that I was situated on or very near the northern limit of annularity, but distant from the central line by three miles. * * * *

"The sun continued visible only by snatches, until after the greatest phase of the eclipse, when the sky became uniformly overcast, and a small steady rain set in for a considerable time. It was long before I could perceive any departure from the usual amount of light. At 12h. 32m. it might have been an ordinary dull day. Birds were then no way affected, and were singing cheerily. I estimated about two-thirds of the sun to be obscured. At 12h. 39m. there was a very perceptible gloom to the north, and the sun's crescent shone out with a bright silvery light, between breaks, clearer than it had been before. At 12h. 43m. the gloom was general, excepting around the sun, which appeared the centre of a circle of light, and illuminated with fine effect some bold irregular masses of cumulus in its vicinity. At 12h. 45m. the gloom increased, slight rain fell, and the wind rose higher; birds were now heard chirping and calling. At 12h. 53m. a severe storm might have been supposed impending, and numerous birds were flying homewards; the deepening of the gloom was gradual, but very slow, and between 1h. and 1h. 1m. was at its greatest intensity; but even at this time the obscurity was not sufficient to require that any employment should be suspended. I myself, situated in an open garden at the time, found no difficulty in reading ordinary type at any ordinary distance. Messrs. Adams and Symms, in the brick-field adjoining, spoke of the gloom as very intense for a period of ten seconds, and sufficient to render it difficult to take the readings of the thermometer. At the time of greatest obscurity a body of rooks rose from the ground and flew homewards; also a flock of starlings rose together, and various small birds flew wildly about. A hare was seen to run swiftly across a neighbouring field as though it were daybreak. Straw rustled, and the silence was peculiar and intense, broken only by the hollow sound of the wind, as it whirled in gusts between the trees; the darkness and intervening lull was that of an approaching thunder-storm. The sky was overcast in the neighbourhood of the sun, principally with cirro stratus: directly after the greatest intensity the gloom was sensibly and instantaneously diminished, and in a very short time the day was restored to its ordinary appearance."

"*As the eclipse* proceeded, the illuminated crescent of the sun

assumed a pure silvery brightness, like that of Venus after inferior conjunction with the sun. The absence of all yellow in its brightness was remarkable; and at the time when the annulus was nearly formed, it appeared like a line of silver wire. The clearing up of the gloom directly after its greatest intensity, and almost immediate return to the general effect of an ordinary dull day, was very marked, and could not fail to be observed by every one. The effect of the unwonted darkness upon birds would seem to have been general; mention is made all over the country of the return of rooks to their rookery; starlings were seen in many places taking flight, whole flocks of them together; near Oxford, Dr. Collingwood remarked that a thrush commenced its evening song. At Grantham, pigeons returned to their cote during the time of the greatest obscuration. In Greenwich Park the birds were hushed, and flew low from bush to bush; and at most places during the darkness the song of many birds was stilled. At Campden Hill it was observed that the crocus closed about the same time, and at Teignmouth that its colour changed to that of the pink hepatica. The darkness was not sufficient at any place to prevent moderate-sized print being read at any convenient distance from the eye out of doors, but difficulty was sometimes experienced in reading the instruments. At Grantham, the darkness is described to have been about equal to the usual amount of light an hour before sunrise.

"The general impression communicated was that of an approaching thunderstorm. The sudden clearing up of the gloom directly after the greatest phase was like the rapid withdrawal of a curtain from the window of a darkened room."

"The Meteorological and Physical Results of the Solar Eclipse," by Mr. Glaisher, with Tables and Diagrams, have been published by the British Meteorological Society, and form a very interesting record of the phenomenon, by the above able Meteorologist, and other observers in various parts of the country.

TOTAL ECLIPSE OF THE SUN.

In the Reports of the French Academy of Sciences, we find the following account of the Solar Eclipse of the 7th of September, 1858, by M. Liais, taken on the Brazilian side of South America.

M. Liais joined an expedition which the Brazilian Government had fitted out for Paranagua, in order to observe the eclipse, which was to be total there. The expedition sailed for the Bay of Paranagua on the 18th of August, and arrived there on the 20th. A central station was established near the coast in 25 deg. 30 min. 33·2 sec. S. lat., and 50 deg. 47 min. 23 sec. W. long. from the Observatory of Paris. A secondary northern station was established on the island Dos Pinheiros, eight leagues from the central station, in lat. 25 deg. 23 min. 24 sec., and long. 50 deg. 36 min. 16 sec. Another secondary station was situate at Campinas, beyond the mountains, in lat. 25 deg. 30 min. 11 sec., and long. 51 deg. 11 min. 1 sec. The following table shows the results of the observation at these stations:—

	Central station.	Pinheiros.	Campinas.
	h. m. s.	h. m. s.	h. m. s.
First external contact	Clouds.	9 36 13	Clouds.
First inner contact	11 0 24·8	11 1 18·2	10 59 5
Second inner contact	Clouds.	Clouds.	Clouds.
Second outer contact	0 28 36	Clouds.	0 25 5

At Rio Janeiro, where the eclipse was only partial, the first contact took place at

10 h. 1 min. 22·5 sec.; at Pernambuco, at 10 h. 27 min. 47 sec. The last contact occurred at Rio Janeiro at 0 h. 54 min. 18·5 sec., and at Pernambuco at 0 h. 54 min. 11 sec. At Rio Janeiro, the solar spots had been copied with much precision immediately before the eclipse; at Paranagua they were copied on the same day and the day following. When the moon approached the spots, different but slight variations of its disc were perceived at the various observatories, such as a slight indentation, a variation of intensity, and another of colour, all owing to irradiation, contrast, or diffraction. At the central station some, but not all, of the telescopes showed a portion of the moon's disc outside the sun at the commencement of the eclipse, but not later. The whole disc was found impressed on the photographs taken while the sun was only partially eclipsed. At Pinheiros and Pernambuco the moon's disc was seen entire before and after the eclipse. All terrestrial objects assumed a yellowish hue during the eclipse: the froth of the sea had the colour of sulphur. The sky, shortly before the total eclipse, had a dark blue tinge; at the time of the greatest obscuration, it assumed the grayish blue tint peculiar to lead. The outline of the moon was surprisingly regular, and it required glasses magnifying the object 300 times to detect three slight irregularities. Nevertheless, on the sun's disappearing entirely, and on its reappearance, the outline of the moon became indented like a saw, and the solar crescent assumed the appearance of a row of pearls. The only heavenly bodies seen during the total eclipse were the planets Venus, Mercury, and Saturn, and the stars Sirius, Canopus, and three others, apparently Alpha and Beta Centauri, and Alpha of the Southern Cross. Venus was seen long before and after the greatest obscuration. The phenomenon called the "crown" occurred in all its splendour. It did not form a well-defined ring; it was yellowish near the moon, and of a silvery white further off. Its breadth was found to be about 34 minutes. Five large groups of conical rays were observed to have their base on the limb of the moon; two were situated on the upper part, right and left of the vertical line, and two others were similarly placed below. The fifth was inclined, its extremity being turned upwards. Many other much shorter rays, perpendicular to the limb, were seen all round. It was evident, from the motion of the moon, that the crown really belonged to the sun. It continued to be visible for 18 or 20 seconds after the reappearance of the sun. At Pinheiros and at the central station a circle, presenting the colours of the rainbow, was perceived around the crown. Six protuberances were observed in all—three perfectly white on the eastern limb and two on the western one of a light rose colour. The sixth did not appear until the *maximum* obscuration, and was like the two latter. Twelve photographs of the sun partially eclipsed were obtained.—*Galignani's Messenger, November*, 1858.

A total eclipse of the sun was observed, under very favourable circumstances, on the 8th of September last, by Mr. Gillis, of the United States, on board the French frigate *Vialète d'Aignan*, in the bay of Schuora, fifteen leagues south of Payta. The obscurity was so great as to allow the stars to be visible, and the phenomenon of Baily's Beads was very conspicuous.

THE COMET OF DONATI.

COMPARATIVELY few of the present generation have seen such an astronomical phenomenon as this brilliant Comet, which followed very nearly its approximate path, as calculated from a few of its observed positions, till it became a remarkable object to the naked eye, and on every clear night was beheld with wonder and pleasure by thousands. From among a mass of observations we select the following, made by Mr. Hind, at Mr. Bishop's Observatory, Regent's Park.

This comet was first discovered by Dr. G. B. Donati, astronomer at the Museum of Florence, on the evening of the 2nd of June, in right ascension 141° 18′, and north declination 23° 47′, corresponding to a position near the star λ Leonis. Previous to this date we had *no knowledge of* its existence, therefore it was not a predicted

comet; neither is it the one last observed in 1556. At the date of discovery it was distant from the earth 228,000,000 miles, and was an excessively faint object in the largest telescopes. This circumstance, added to its very slow motion, rendered the calculation of its path in the heavens a matter of considerable difficulty; and it was not until the middle of August, or later, that a trustworthy determination of its future track among the stars could be obtained. It was then fairly within our grasp, and astronomers are not likely to be ignorant of its position to any extent until it is again within the range of the telescope in Europe more than 2000 years hence.

The general telescopic appearance of the comet had not materially altered by September 27, but some of its features had come out more distinctly. In a somewhat hazy sky on the 27th, the apparent length of the tail was about twelve degrees, corresponding to a real length of 16,000,000 miles. As usual in great comets, the tail was very visibly curved in the opposite direction to that of the motion of the nucleus.

The tail, from October 1 to 15, when the comet was most conspicuous, appears to have maintained an average length of at least 40,000,000 miles, subtending an angle varying from 30° to 40°. The dark line, or space down the centre, frequently remarked in other great comets, was a striking characteristic in that of Donati. The nucleus, though small, was intensely brilliant in powerful instruments, and for some time bore high magnifiers to much greater advantage than is usual with these objects. In several respects this comet resembled the famous ones of 1744, 1680, and 1811, particularly as regards the signs of violent agitation going on in the vicinity of the nucleus, such as the appearance of luminous jets, spiral offshoots, &c., which rapidly emanated from the planetary point, and as quickly lost themselves in the general nebulosity of the head.

On the 5th of October the most casual observer had an opportunity of satisfying himself as to the accuracy of the mathematical theory of the motions of comets in the near approach of the nucleus of Donati's to Arcturus, the principal star in the constellation Bootes. The circumstances of the appulse were very nearly as predicted by Mr. Hind:

"On the evening of October 5th the nucleus will make a near approach to Arcturus, the principal star in the constellation of Bootes, which, according to calculations, will be near the border of the tail during the early part of the evening, and as it descends towards the horizon may possibly be enveloped in that appendage. If the sky be clear, this close approach of the comet to so conspicuous a star will doubtless prove a very interesting phenomenon. At 6 P.M. their distance will be little more than one-third of a degree."

Upon this Mr. W. R. Grove makes the following observations:—

When the comet (star) had entered well within the margin of the tail a dark *notch was formed*, cutting out a portion of the tail round the star; and as the star *got further in*, this became a dark areola surrounding the star, and in diameter *equal to about* one-tenth of the line of transit. This continued until the star *reached the middle*; at this part there is a broad dark line which extends from the

nucleus to a distance considerably above the point where the star crossed. When *Arcturus* arrived here, this dark space was perfect up to the star, but on the other side the white light of the tail appeared to come quite up to the star; in short, as the bright part of the tail had been darkened in the vicinity of the star, the dark part was brightened, at least so much of it as was on the side furthest from the nucleus. I saw the notch again on the opposite side previous to immersion, and then lost it by clouds. The effects I have described are, doubtless, optical, and the notch and areola evidently due to the bright light of this star: the effect to the dark central part is not so easy to explain.

Several attempts were made to determine the real nature of the comet's track in the system; and from the investigation by Mr. Loewy, of the Observatory of Vienna, Mr. Hind gives several deductions, premising that the length of the major axis of the ellipse, and consequently the duration of the revolution, are liable at present to more uncertainty than the other numbers, though we may perhaps depend upon them within an eighth or a tenth of the whole. In a few months' time more reliable quantities will doubtless be in our possession.

"The comet arrived at its least distance from the sun a few minutes after 11 o'clock on the morning of the 30th of September; its longitude, as seen from the sun at this time, being 36° 13′, and its distance from him 55,000,000 miles. It ascended from the south to the north side of the ecliptic 186½ days before the perihelion passage, or on the 27th of March, 1858, distant from the sun 3·11, or situate among the orbits of the minor planets, and will again traverse the plane of the earth's path, moving south, on October 18th, 18½ days after perihelion, at a distance of 0·71. The longer diameter of its orbit is 184 times that of the earth's, or 35,100,000,000 miles, yet this enormous space is considerably less than one-thousandth of the distance of the nearest fixed star! The smaller diameter of the ellipse is about 2,780,000,000. The orbit is inclined to the ecliptic at an angle of 63° 2′, and intersects it in longitude 165° 19′ and 345° 19′. From what has been here stated, it will be seen that the comet remains on the north side of the earth's path only 205 days, so that nearly the whole of its vast trajectory is situate below or rather to the south of that plane. The time of revolution resulting from Mr. Loewy's calculations is 2495 years, which is about 500 years less than that of the comet of 1811, during the period it was visible from the earth. The hourly velocity of the comet in its orbit varies between 127,000 miles at the perihelion and 480 miles at the aphelion.

"The above numbers are probably a fair approximation to the true ones for this date; but it does not follow, because certain elements represent the comet's path at any particular time, that they will long continue to do so. This remark applies more especially to the length of the revolution, and as a case in point, I may mention the result of Argelander's calculation with respect to the grand comet of 1811. In the autumn of that year, when it was most brilliant, the time of revolution corresponding to the ellipse it was then describing was something over 3060 years; but in 1827, the comet was moving in an ellipse of 2890 years, showing an alteration approaching two

centuries due to planetary perturbations, and for aught we know at present, the period of Donati's comet may be similarly altered."—*Mr. Hind's Letter*, October 16.

On October 18, the comet nearly approached the planet Venus, which had "a rather narrow escape from immersion in the denser part of the tail, if not from actual collision with the nucleus." The nearest approach of the two bodies took place early on the morning of the 18th, when their mutual distance was less than .9-100ths of the earth's distance from the sun; consequently, on this occasion, no very near approximation occurred, yet it is obvious that if the comet had reached its least distance from the sun a few days earlier than it did, the planet might have passed through it, and Mr. Hind is very far from thinking that close proximity to a comet of this description would be unattended with danger. The inhabitants of Venus witnessed a cometary spectacle far superior to that which attracted so much attention here, inasmuch as the tail doubtless appeared twice as long from that planet as from the earth, and the nucleus proportionably more brilliant.

The comet was not visible in this country after the end of the third week in October, unless a few daylight observations were procured.

After the comet was lost to view in Europe, it traversed the southern extremity of the constellation Sagittarius, and thence passed through Telescopium into Indus, where it was found about Christmas, not far from the star α in Pavo. It will remain in the same constellation during January and part of February, slowly approaching the principal star in Toucan, and, indeed, will continue in that part of the heavens until it has nearly completed its next revolution round the sun, and again presents itself to the gaze of another Donati a few hundred years hence.

Admiral Smyth, who observed the comet of 1811 for several months in the Mediterranean, considers the comet of Donati the most splendid in appearance. He writes:

"As a mere *sight* object, the branched tail of the comet of 1811 was of greater interest, the nucleus with its 'head-veil' was more distinct, and its circumpolarity was a fortunate incident for gazers.

"With those exceptions, Donati's is one of the most beautiful objects I have ever seen in the heavens. The head is certainly not so fully pronounced as in that of 1811; but greatly its physical interest is increased by segments of light and a dark hollow, giving the aspect a resemblance to the gaslight called a bat's-wing . . . . This dark line, or space down the centre of the brilliant phenomenon, not only had the direct tendency to strengthen the luminosity of the jets of light, in the manner observable in the burning of a wax taper, but also, on a fuller scrutiny of this singular characteristic, to recall its striking resemblance to the similar feature seen in waterspouts, and in the pillars raised in sand-storms which I have witnessed in North Africa."

Lastly,—M. Chacornac, of the Paris Observatory, states that with Arago's polariscope he detected evident traces of polarization in the light of Donati's comet.

METEOROLOGY OF 1858.

Results deduced from the Meteorological Register kept at the Royal Observatory, Greenwich, during the year 1858, *under the Superintendence of the Astronomer Royal.*

Months.	Mean Reading of Barom.	Mean Tension of Vapour.	Mean Pressure of Dry Air.	Temperature of Air. Mean for Month.	Highest by Day.	Lowest by Night.	Mean of all the Highest.	Mean of all the Lowest.	Range in Month.	Mean Daily Range.	Temperature of Evap.	Evap. below Air.	Dew Point below Air.	Dew Point.	Rain. No. of Days.	Amount in Inches.	Weight of Vapour in cubic ft. of Air.	Mean additional Weight required to saturate a cubic foot of Air.	Mean Degree of Humidity. Saturation = 100.	Mean Weight of a cubic foot of Air.
	In.	In.	In.	°	°	°	°	°	°	°	°	°	°	°		In.	Gr.	Gr.		Grs.
Jan.......	30.171	·194	29·977	37·5	51·9	20·9	43·8	31·7	31·0	12·1	35·9	1.6	3·7	33·8	5	0·7	2·2	0·4	86	563
Feb.......	29·841	·169	29·672	34·6	52·8	23·5	41·8	29·8	29·3	12·0	33·0	1·6	4·2	30·4	6	1·7	2·0	0·3	84	560
March..	29·765	·201	29·564	41·4	68·7	23·6	50·7	33·6	45·1	17·1	38·4	3·0	6·8	34·6	8	0·9	2·3	0·7	78	551
April....	29·779	·236	29·543	46·2	76·0	27·2	57·6	38·0	48·8	19·6	42·7	3·5	7·5	38·7	11	2·4	2·7	0·9	76	546
May......	29·709	·285	29·424	51·7	81·2	32·1	63·7	42·7	49·1	21·0	47·7	4·0	8·1	43·6	17	1·8	3·2	1·1	75	538
June ...	29·915	·414	29·501	64·9	94·5	45·3	79·5	53·9	49·2	25·6	58·8	6·1	11·2	53·7	5	1·2	4·6	2·2	67	527
July ...	29·781	·380	29·401	60·6	88·2	43·8	73·8	51·8	44·4	22·0	55·7	4·9	9·1	51·5	12	2·9	4·3	1·7	72	529
Aug......	29·826	·385	29·441	62·0	86·9	43·3	75·6	52·1	43·6	23·5	56·5	5·5	10·3	51·7	8	1·6	4·3	1·9	70	529
Sept. ...	29·865	·408	29·457	60·3	83·8	41·5	70·9	52·6	42.3	18·3	56·6	3·7	6·9	53·4	10	0·9	4·6	1·3	78	531
Oct.......	29·834	·313	29·521	50·8	69·5	33·0	59·9	43·9	36·5	16·0	48.5	2·3	4·7	46·1	9	1·2	3·6	0·6	85	541
Nov.......	29·750	·209	29·541	39·6	58·0	20·5	46·1	33·6	37·5	12·5	37·9	1·7	3·9	35·7	7	0·4	2·4	0·4	86	552
Dec.......	29·771	·227	29·544	41·0	53·5	30·3	45·1	36·6	23·2	8·5	39·6	1·4	3·2	37·8	14	1·5	2·6	0·4	89	551
Means...	29·834	·285	29·549	49·2	72·1	32·1	59·0	41·7	40·0	17·3	45·9	3·3	6·6	42·6	112 Sum	17·2 Sum	3·2	1·0	79	543

EXPLANATION.

The cistern of the barometer is about 159 feet above the level of the sea, and its readings are coincident with those of the Royal Society's flint-glass barometer. The observations are taken daily at 9 A.M., noon, 3 P.M., and 9 P.M.; the means of these readings are corrected for diurnal ranges by the application of Mr. Glaisher's corrections, as published in the *Philosophical Transactions*, Part I., 1848, and from the readings of the dry and wet bulb thermometers, thus corrected, the several hygrometrical deductions in columns 3, 15, 18, 19, 20 and 21, are calculated by means of Mr. Glaisher's Hygrometrical Tables. *Second Edition.*

The numbers in column 2 show the mean reading of the barometer every month, or the mean length of the column of mercury which balanced the whole weight of atmosphere of air and water; the numbers in column 3 show the length of a column of mercury balanced by the water alone; and the numbers in column 4 show the length of a column of mercury balanced by the air alone, or that reading of the barometer which would have been had no water been mixed with the air.

[*Concluded on next page.*

The reading of the barometer was above its average value in January, February, April, June, August, September, and October; and in defect in the remaining months in the year.

The mean reading of the barometer for the year, at the height of 160 feet above the mean level of the sea, was 29·820 inches, being somewhat above the average value.

The mean temperature of the air in January was in excess of the average value of 87 years by 1⅓°; February, in defect, by 3¾°; March and April, in excess, by ½°; May, in defect, by ¾°; June, in excess, by 7°; July, in defect, by ¾°; August, in excess, by 1⅓°; September, by 4⅓°; October, by 1⅓°; November, in defect, by 3°; and December, in excess, by 2°; according to Mr. Glaisher's determination of the mean temperature of each month.

The mean temperature of the air for the year was 49·2°; that of evaporation was 45·9°; and that of the dew-point, 42·6°. The mean degree of humidity was 79, complete saturation being represented by 100. Rain fell on 112 days; the amount collected was 17·2 inches.

Till January the 7th, the air was cold, and the mean daily defect of temperature was ½°; from the 8th to the 20th, the average excess was 4¾°; and then to the 27th it was cold, the average deficiency amounting to 4¼°, when another warm period commenced, and continued to the end of the month; the mean daily excess being 4¾°. February was cold nearly throughout, excepting on the 3rd, 4th, 5th, 6th, and 13th, when the temperature somewhat exceeded the average. The mean temperature of this month was about 4° below the average of the preceding 17 years. March was cold till the 12th, being 8° in defect; and from the 13th to the end of the month was warm, being 5½° in excess. This month was nearly of its average temperature. April, till the 14th day, was very cold, being 4½° in defect; from the 15th to the 26th was hot, being 6° in excess; and again became cold till the end of the month, the average defect being 1⅓°. The mean temperature of the month was about the average. May was cold till the 15th, being 4° deficient from the average; was then warm till the 24th, averaging 1¼° in excess; from the 25th to the 28th it was again cold, being 2½° in defect; and then became hot till the end of the month; the average excess being 7⅓°. The mean temperature of this month was 1° in excess. June was hot throughont, the average excess being 6°. On the 16th, the temperature near the sea rose to 88°; and between the latitudes 51° and 52° reached the point 95°. The mean temperature of this day at Greenwich was 76·9°; and there is no previous instance of so high a mean temperature in the month of June. The mean temperature of this month (64·9°) has been but once exceeded since the year 1771, a period of 87 years—viz., in the year 1846, when it was 65·3°. July, till the 10th, was cold, being 6° in defect; from the 11th to the 25th it was warm, being 2⅓° in excess; and was then cold till the end of the month, the average defect being 2½°. August was warm till the 24th, and cold during the remainder of the month; the mean excess for the month being 1⅓°. September was warm throughout, being 4° in excess of the average of 87 years. October was alternately warm and cold, and the mean temperature of the month exceeded the average by 1⅓°. November was very cold till the 24th, being 6° below the average; the mean temperature of the 23rd and 24th was lower than that of any two consecutive days in November during the last 45 years; the remainder of the month was warm, being 5¾° in excess. December was about ½° above the average.

The temperature of the year 1858 was about ¾° above the average of the preceding 87 years. The highest temperature in the year was 94·5°, in June; the lowest was 20·5°, in November; therefore, the range of temperature in the year was 72·0°. The greatest range in one month took place in June, and was 49·2°. The average monthly range of temperature was 40°, and the average daily range was 17½°. The mean weight of a cubic foot of air was 563 grains in January, 527 grains in June, and the average for the year was 543 grains.

Thunderstorms were very prevalent in June. At many places they were described as being more terrific and violent than had been known for many years.

Wheat was cut on July 17th at Royston; on the 9th at Berkhampstead; on the 20th at Cardington and Osborne; on the 23rd at Teignmouth; on the 26th at Little Birdy and Grantham; on the 27th at Barnstaple and Belvoir; and on the 28th at Norwich. On August 2nd at Helston; on the 3rd at Fairlight; and on the 7th at Stonyhurst.

Barley was cut on the 26th of July at Bywell; on the 29th at Helston and Royston; and on the 31st at Osborne and Little Birdy. On the 5th of August at Berkhampstead; on the 20th at Grantham; and on the 25th at Fairlight.

Oats were cut on July 13th at Helston; on the 14th at Osborne; on the 28th at Grantham; on the 27th at Belvoir; on the 29th at Barnstaple, and on the 30th at Little Birdy. On August 2nd at Berkhampstead; on the 7th at Fairlight; and on the 28th at Stonyhurst.

Obituary.

LIST OF PERSONS EMINENT IN SCIENCE OR ART. 1858.

Dr. John Forbes Royle, F.R.S., F.L.S., F.G.S., the distinguished botanist, and illustrator of the Flora of Hindustan.

Alexander Black, architect.

Benjamin Travers, surgeon.

G. F. Creuzer, German antiquary and philologist.

John Hogan, sculptor. His statue of O'Connell, in the Exchange, Dublin, is considered a masterpiece.

John Seaward, civil engineer.

Dr. William Gregory, Professor of Chemistry in the University of Edinburgh. As a scientific man, he worked more for utility as a teacher than for fame as a discoverer. His principal memoirs were on Pyroxanthine, a solid volatile product of the destructive distillation of wood; on a Compound of Sulphur and Nitrogen; and on the Decomposition Products of Uric Acid; whilst to practical chemistry he contributed improved processes for the preparation of hydrochloric acid, oxide of silver, and muriate of morphia. He is better known, however, for his writings than his laboratory work. His thorough knowledge of Organic Chemistry, which he embodied in an elementary work, which, in a succinct form, presents the best *résumé* of chemistry, especially in the organic department, which exists in the English language. The last volume of the *Transactions* of the Royal Society of Edinburgh contains an elaborate and beautifully illustrated memoir by Dr. Gregory on this subject.

Peter Frederick Robinson, architect; one of the first Members of the Institute of British Architects.

Alexis Soyer, the celebrated *cuisinier*. His labours at Scutari and in the Crimea to reform the wasteful system of cookery deserve to be remembered with gratitude by the British Army.

Dr. Bright, distinguished by his many services in the profession of medicine, as an author, practitioner, and lecturer.

Aimé Bonpland, naturalist; "the beloved noble friend and travelling companion" of Alexander von Humboldt.

M. Poitevin, the intrepid aëronaut; he fell into the sea near Malaga, when descending with his balloon, and was drowned.

Professor Müller, of Berlin, physiologist.

Baron von Neimans, of Bayreuth, in Franconia, who intended to make a journey into the interior of Africa, in order to ascertain the fate of Dr. Vogel.

Professor Franz Kugler, known by his many excellent works on the history of Art, at Berlin, where he had filled for some years an important position in the Ministry of Public Instruction.

William Horsley, "one of the patriarchs of English music, and certainly one of the best composers this country has ever produced."—*Athenæum*.

Louis Augustin Prevost, the Chinese scholar.

Thomas Tooke, political economist, F.R.S., author of the well-known *History of Prices*; and a Corresponding Member of the French Academy.

Gottfried Nees von Esenbeck, the natural philosopher. In 1817, he was named Professor of Botany at the University of Erlangen; was chosen, in the same year, President of the Imperial and Royal Academy of Natural Philosophy, at Vienna: lived, from 1818 to 1830, as a public lecturer at the University of Bonn, and was then called in the same capacity to the University of Breslau. In 1848 and 1849 a partisan of the Revolutionary movement, he, in 1852, was dismissed, without a pension, from public service. In consequence of this the last years of the veteran were passed in indigence and want. He parted with his valuable library and scientific collections, and had, besides, to recur to the assistance of his friends and former pupils for the modest maintenance of a rapidly declining life.—*Athenæum*.

Major-General Sir William Reid, late Governor of Malta. As Chairman of the Executive Committee of the Great Exhibition, and as the author of *A Theory of the Law of Storms*, he came prominently under the notice of a literary and scientific audience. Yet if we were called upon to write his epitaph, we should simply add to his name, Author of *The Law of Storms*.

Dr. George Peacock, Dean of Ely; mathematician and astronomer. He held the *Lowndean Professorship*, at Cambridge, for many years. Dr. Peacock edited *the Works of Dr.* Thomas Young, his defence of whose claims is a noble *service to science*.

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THE END.

and imperfections unavoidable in first appearances of so ambitious a character—former editions have received from the reading public. In this respect, it is hoped the present edition will not be less fortunate than its predecessors.

The plan and objects of this work are so clearly indicated in its title-page, that it becomes unnecessary to expatiate on these subjects. It had its origin in the aspiration of a distinguished journalist, over whom the grave has now closed, to fill a place previously unoccupied by any of the multifarious Books of Reference which the industry and enterprise of the age have provided for almost every class of the community. We had numerous records of the aristocracy of birth, and even of wealth: we had Peerages, and Histories of the Landed and Commercial Gentry of the United Kingdom; we had Red Books, Court and Imperial Calendars, Parliamentary Guides, and Post-Office Directories, which left no official dignity, no civil service unchronicled. We had lists also of Military and Naval Officers, and of the Clergy, which set forth with laudable exactness the heroic deeds, rank, or emoluments of the members of these most important professions. Lawyers and Politicians had also their respective muster-rolls. But the Aristocracy of Genius had been left, hitherto, without any special record of its deserts. The aim of the following pages is to furnish, in as compact a form as possible, a series of Biographical Sketches of eminent living persons in all parts of the civilized world; one which, limited to no particular class, addresses itself to all; thus presenting the largest body of contemporary biography which has hitherto appeared in this or any other country. A preface to a book whose character may be ascertained by a glance at the title-page and table of contents, would appear to be almost unnecessary; but as perfection is rarely attained under any circumstances, and can hardly be looked for in a work which embraces so large a body of dates and facts as will be found in the following pages, a few words in explanation of the difficulties which have attended its compilation, and the means which have been adopted to overcome them, may not be considered superfluous.

Necrologies of eminent persons are doubtless among the most valuable and instructive products of literary industry; but the materials of which they are composed may often be obtained by mere "pains and pulling down of books." Even when derived almost entirely from unpublished documents, the biographer has seldom to go far a-field for his materials; for they are usually furnished to him in bulk—to be analysed, balanced, and appropriated at his leisure. With the biography of living characters, however, the case is widely different. The data are far less accessible, and even those which have found their way into print are often so highly coloured by party or professional prejudice, that it requires no ordinary care and discrimination to separate the grain from the chaff. Official records do not, indeed, fall within this category; but such repertories supply little beyond the dry husks of biography. After all has been gleaned that can be collected from them, much is still indispensable that can only be derived from private records, and in many instances we have had to rely altogether on such resources. Indeed, had it not been for the assistance which has thus been afforded to us in the prosecution of our task by a numerous body of private correspondents, who have either supplied us with facts themselves or have enabled us to verify those which we have obtained elsewhere, these pages could never have approached the form they have now gradually assumed. Among the difficulties of such an undertaking, which it has not been possible to obviate altogether, has been that of establishing such a standard of selection as would have enabled us to allocate the amount of space allotted to the respective names in more strict accordance with their relative claims. In some instances, in which more minute details would have been desirable, the means of obtaining them were not within our reach. In others, the value of the materials may have tempted the respective writers to exceed their prescribed limits; while on more than one occasion the discrepancy has been caused by circumstances purely accidental.

In the memoirs which have been introduced of crowned heads *and their ministers,* some description has been given of the policy

peculiar to each court and government; and in those of men of letters and of science, of artists, philosophers, &c., analyses have been included of their respective works and discoveries, which will enable the reader to form some notion of their real claims upon public notice: thus rendering the work a compendious Handbook of Contemporary History. It ought, however, to be mentioned, that no attempt has been made to reduce the political opinions conveyed by the respective writers of these sketches to any uniform standard. Men of all politics, whose general claims upon public attention have entitled them to honourable mention in its pages, have received their due meed of praise, without reference to their political bias. Even political acts of questionable prudence, which appear to have been dictated by conscientious and patriotic motives, have been duly respected.

The present edition of "Men of the Time" cannot claim the merit of very closely approaching perfection. Nevertheless it will be recognised as, in many respects, comparing advantageously with its predecessors. Errors have been corrected, omissions supplied, the pruning-hook applied where obviously necessary, and sketches of more than sixty living celebrities included among those that formerly appeared. As many of these hold high rank in their various professions, and bear names known and respected throughout Europe, this addition will be deemed by no means unimportant.

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